PERIODICAL TECHNOLOGY DEPT.

First Copy

Construction Methods

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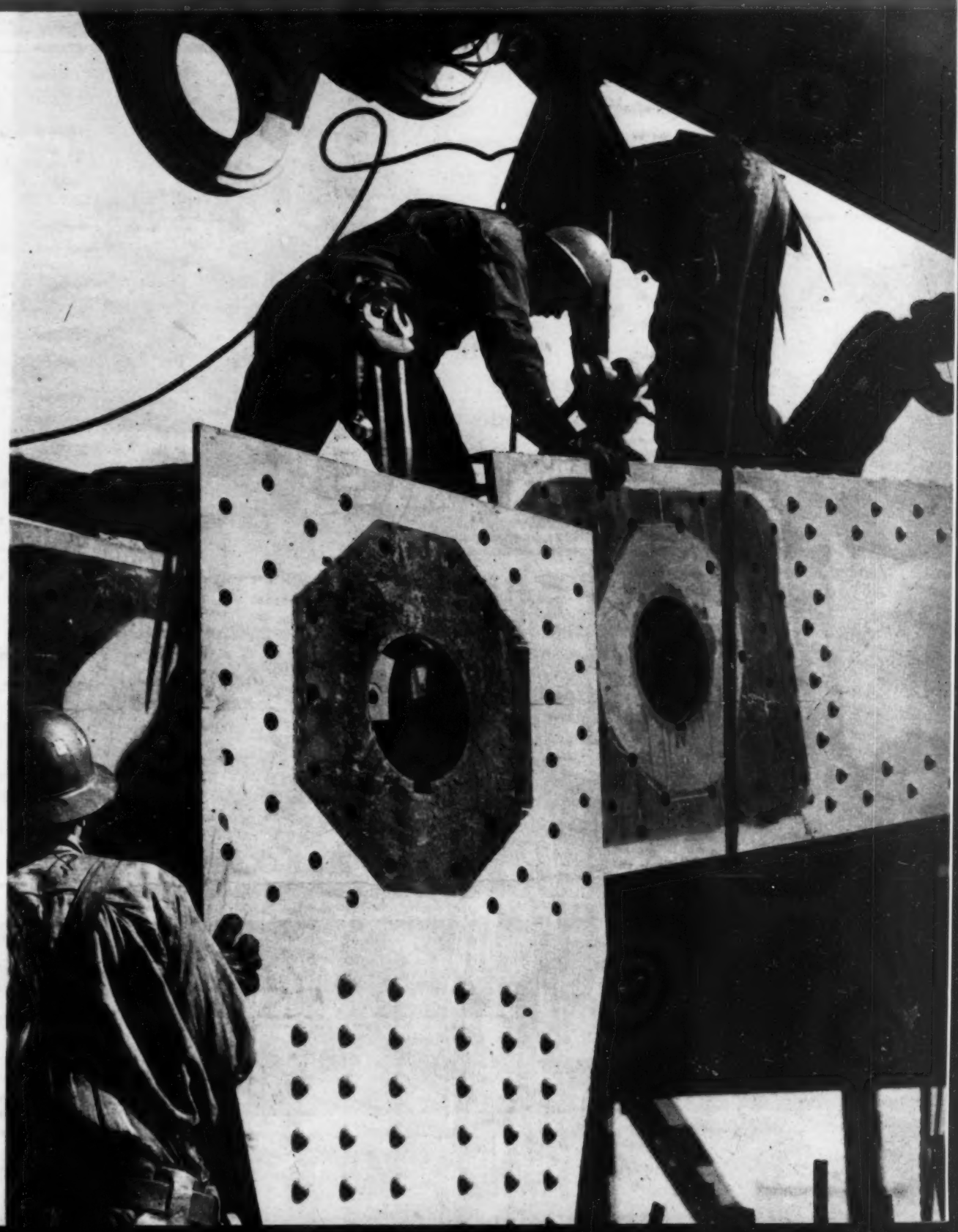
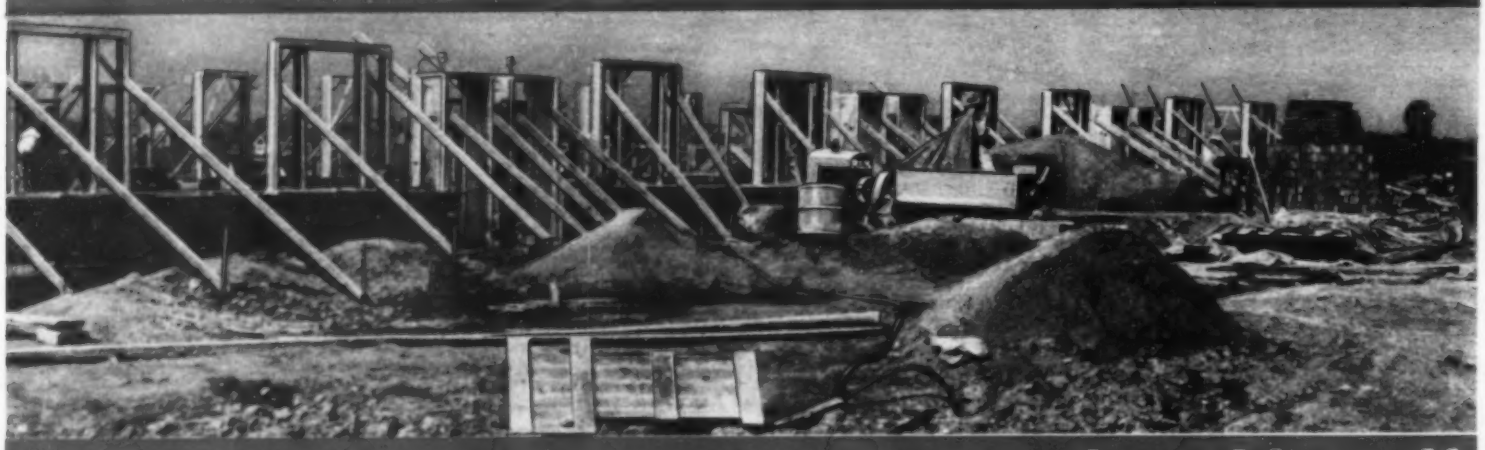


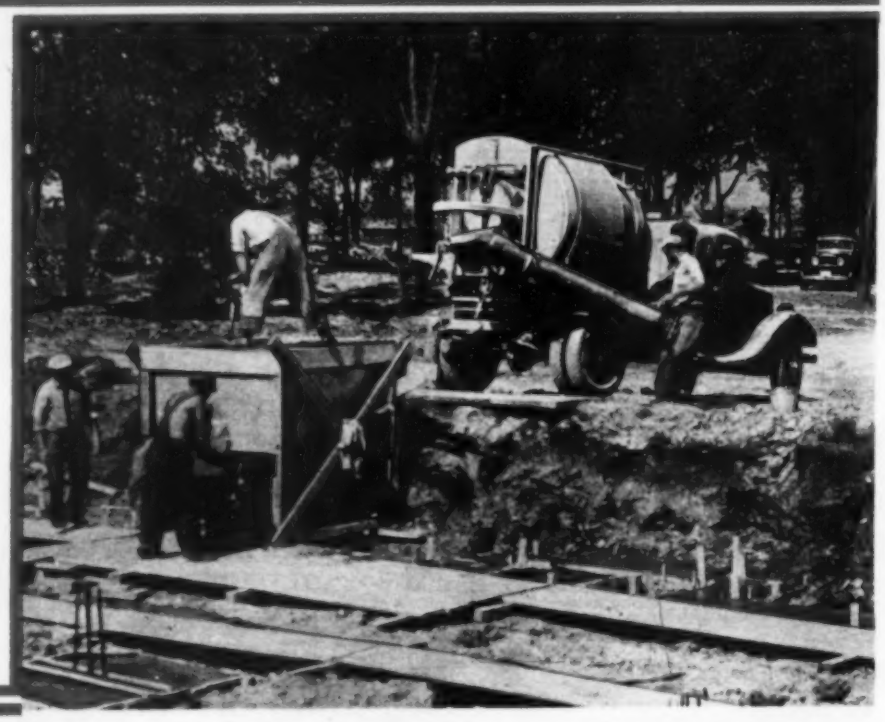
LAST CHORD is erected July 17 in San Francisco-Oakland Bay bridge. Big 5-ton steel girder, 30 ft long, is manipulated into place in one hour by twelve bridgemen. South upper steel member is approximately last of 153,000 tons of structural steel erected for $77,200,000 California-owned bridge.

When Final Savings are Greater than the First



It Proves How It Pays to Forget the Old Stuff

This housing project is now nearing completion. It was originally laid out for standard methods of mixing and placing concrete. Then investigation proved substantial savings could be made by using Rex Moto-Mixers. These estimates showed that Rex Moto-Mixers and a central batching plant made up the lowest cost way of handling the job.



SAVINGS HAVE EXCEEDED THE ESTIMATE

Direct cost of concrete in place is lower than the estimate. Maintenance cost of equipment has been less per yard of concrete. Two important items of expense, moving of equipment and loss of aggregates in ground storage, have been eliminated. On this job involving 17,000 yards of concrete, placed in all the spots called for in building a complete village of 250 small homes, scattered over 42 acres, it has more than paid to completely forget the old stuff.

How well it paid is evidenced by the fact that the contracting company (nationally and internationally known) is now setting up for another housing project — and the concrete will be handled by Rex Moto-Mixers.

Before you buy, before you bid, investigate the Up-to-Date Methods of Handling Concrete

CHAIN BELT COMPANY
1664 West Bruce Street, Milwaukee, Wisconsin

REX *Moto-Mixers* *Construction Equipment*

TECHNOLOGY DEPT.

Construction Methods

McGraw-Hill Publishing Company, Inc.
330 West 42nd St., New York

ROBERT K. TOMLIN, Editor

SEPTEMBER 1936

WILLARD CHEVALIER, Vice-President

Editorial Staff: Vincent B. Smith, John B. Huttl (San Francisco)
Nelle Fitzgerald

Current Jobs

Sewers

In Detroit, **S. A. Healy Co.**, of Detroit was successful bidder on a $1,804,530 section of the Detroit River Interceptor. Corpus Christi, Tex., awarded to **McKenzie Construction Co.**, of San Antonio, Tex., $602,848 contract for sewer construction.

Healy-Tibbitts Construction Co., of San Francisco, received an award of $334,259 for sewer construction in that city. A Denver, Colo., sewage disposal plant went to **Peter Kiewits Sons Co.**, of Omaha, Neb., for $1,156,192. **Bryant & Detwiler**, of Detroit, bid low at $495,820, for sewage works at Columbus, Ohio. A $1,210,665 outlet sewer contract in Chicago, was obtained by **Herlihy Mid-Continent Co.**, of Chicago. In Buffalo, N. Y., **Merritt, Chapman & Scott**, of New York City, are starting work on a sewer project to cost $738,345.

Waterworks

In Birmingham, Ala., the **Chicago Bridge & Iron Works** and the **Ingalls Iron Works Co.**, were awarded by the city a $1,236,000 contract for 42- to 60-in. steel pipe for water works. Excavating and embankment for Sunset reservoir, in San Francisco, went to **Piombo Bros.**, of San Francisco, for $238,121.

Among the larger waterworks contracts were $955,371 to **United Concrete Pipe Co.**, of Los Angeles, and $516,725 to **Western Pipe & Steel Co.**, of Los Angeles, for sections of the upper feeder system of the Colorado River aqueduct. The **Lock Joint Pipe Co.**, of Denver, Colo., was low bidder at $465,791, for constructing conduit for the Moffat tunnel extension.

Dams

For the construction of Bartlett dam, multiple-concrete arch type 240 ft. high and 950 ft. long, on Salt River project near Phoenix, Arizona, the U. S. Bureau of Reclamation has awarded a $2,228,272 contract to **Barrett & Hilp**, of San Francisco, and **Macco Construction Co.**, of Clearwater Calif.

Caballo Dam—For constructing the Caballo dam on the U. S. Bureau of Reclamation's Rio Grande project near Hatch, N. M., the low bid, $957,018, was submitted by **Mittry Bros. Construction Co.**, of Los Angeles. The dam will be of earth, 85 ft. high and 4,250 ft. long. The contract includes a diversion tunnel 14 ft. in diameter and 560 ft. long.

Waterways

Several river and harbor projects in the $2,000,000 range have been placed under contract. They include: Concrete dam on Mississippi River at Quincy, Ill., to **McCarthy Construction Co.**, of Davenport, Ia., for $2,422,132; breakwater at Los Angeles, Calif., to **Rohl-Connolly Co.**, of Los Angeles, for $2,145,000; dredging in New York harbor to **Great Lakes Dredge & Dock Co.**, of New York City, for $1,958,748 and to **Arundel Corp.**, of Brooklyn, N. Y., for $2,037,991; lock and dam on Illinois River at Beardstown, Ill., to **Kansas City Bridge Co.**, of Kansas City, Mo., for $1,964,869; barge canal dredging at Minetto, N. Y., to **Dunbar & Sullivan**, of Detroit, Mich., for $1,919,000; Mississippi River dam at Lynxville, Wis., to **United Construction Co.**, of Winona, Minn., for $1,878,169; removing ledge rock in Harlem River, New York, to the **Arundel Corp.**, of Brooklyn, N. Y., for $782,179; for dredging between Pensacola and Mobile, Ala., to the **Sternberg Dredging Co.**, of St. Louis, for $721,224.

AND WHO'S DOING THEM

How—

... For the benefit of readers concerned with the practical application of method or equipment the following references are to articles or illustrations in this issue that tell:

How ... LEVEE BUILDING is done with diesel-electric dredge equipped with 6-yd. clamshell bucket on 240-ft. boom. —p. 25

How ... UNDERSLUNG RECIPROCATING SCREED, operating under elevated rails on which special finishing machine travels, built monolithic lip curbs simultaneously with bridge roadway slab. —p. 30

How ... SPECIAL ROADWAY FORMS, fastened by adjustable pedestals to transverse I-beam floor joists, aided construction of reinforced-concrete bridge deck. —p. 30

How ... REMOVABLE DECK FORMS, made up in panels for ease of stripping and erection and supported on collapsible timber frames, served eight repeated uses on roadways of Triborough bridge. —p. 32

How ... PORTABLE SELF-SUPPORTING FORM UNITS, 25 ft. long and 20 ft. high, facilitated construction of monolithic concrete walls. —p. 34

How ... COLORED ARCHITECTURAL CONCRETE was produced by adding pulverized clay shale paste to mixture made with ordinary portland cement. —p. 35

How ... STEEL RIBS to support arched roof of 122-ft. span were erected by two crawler cranes. —p. 35

How ... LINING OF STREAMBED was done with concrete silo staves strung on cable to form articulated mat. —p. 40

How ... NIGHT WORK on highway grading projects was made possible by electric flood-lighting. —p. 41

How ... BELT CONVEYOR delivered concrete to flexible spout feeding sidewall forms for canal lining. —p. 42

How ... STEEP-ANGLE BOOM of paving mixer with special bucket placed concrete for storm drain. —p. 42

How ... WHITE CEMENT for traffic guide line was sifted on to fresh concrete through sieve box. —p. 42

How ... CLAY CORES from holes for concrete piles were removed with aid of suction from vacuum tank. —p. 43

How ... MOWING MACHINE on motor truck trimmed grass and weeds on road shoulders. —p. 43

How ... HIGHWAY BROOM rigged with three auto tires leveled center-line windrow. —p. 43

How ... TRUCK-LOAD TALLY was registered by streetcar fare meter. —p. 43

How ... PIPE-TURNING RIG aided bituminous coating of 230-mi. welded line. —p. 43

How ... CONCRETE OBELISK was tipped over by blast and made to fall across streambed to divert river. —p. 45

How ... DIVERSION GATE was lowered to place and sealed to make dam closure. —p. 46

How ... "PORTCULLIS" of steel sheetpiling, suspended from timber frame, formed closure gate on lock and dam. —p. 46

How ... SEGMENTAL ARCH RINGS formed closure for dam in Sweden. —p. 47

How ... POWER-DRIVEN SCREED struck off lower course of concrete ready for bar-mat slab reinforcement. —p. 50

How ... CALCIUM CHLORIDE was used with high-early-strength cement in cold weather. —p. 52

Current Jobs

Buildings

Public—The Housing Division of PWA awarded to **T. L. James & Co., Inc.**, of Ruston, La., a $2,183,000 contract for the superstructure of Lauderdale Courts housing project in Memphis, Tenn. In Jefferson City, Mo., **Boyle-Pryor Construction Co.**, of Kansas City, Mo., bid in for $2,003,000 a group of prison buildings. With a price of $1,403,800, **Walter Butler Co.**, of St. Paul, Minn., obtained from the Housing Division, PWA, the superstructure contract for the Blue Grass Park and Aspendale housing projects in Lexington, Ky. **E. L. Martin**, of Dallas, Tex., obtained the $1,066,700 federal narcotic farm building project in Fort Worth, Tex. A PWA Housing Division project in Columbia, S. C., went to **J. A. Jones Construction Co., Inc.**, of Charlotte, N. C., for $972,500. The **A. J. Rife Construction Co.**, of Dallas, Tex., was successful with a tender of $802,900 for a PWA Housing Division project in Dallas, Tex. In San Francisco construction has been started by the **Clinton Construction Co.**, of San Francisco, on an airport terminal and garage to cost $677,000.

Commercial—Recent awards for commercial buildings include: A $1,000,000 apartment house at Mt. Vernon, N. Y. to be built by **A. Morrell**, N. Y. City; a $525,000 college building at Palo Alto, Calif., to **G. Wagner**, of San Francisco; a $500,000 school building in Syracuse, N. Y., to **Hueber Bros.**, of Syracuse.

Industrial—Libby-Owens Ford Co., of Toledo, Ohio, has selected **A. Bentley & Sons Co.**, of Toledo, to build a $750,000 factory. Two distillery warehouses for J. E. Seagram & Sons in Lawrenceburg, Ind., are being constructed by **J. and E. Warm Co.**, of Cincinnati, Ohio, for $800,000. In Milwaukee, Wis., **Meredith Bros.**, of Milwaukee, are building a $400,000 malt house for the Schlitz Brewing Co.

J. Rich Steers, Inc., and **Standard Dredge Co.**, of New York, bid $3,548,500, for an industrial terminal at Bayonne N. J.

Highways

Mississippi has started to award contracts for its big highway program as follows: $256,293 to **H. E. Wolfe Construction Co.**, of St. Augustine, Fla.; $322,618 to **Stevens Bros.** and **Miller-Hutchinson Co.**, of New Orleans; $236,530 to **Ball Contracting Co.**, of Fayette, Miss. In California, **Barrett & Hilp** and **Pacific Bridge Co.**, of San Francisco, on a joint bid obtained for $800,000 paving on the main, side and approach spans of the Golden Gate Bridge. Missouri road-building contracts went to **F. A. Schmitt Construction Co.**, of St. Louis, for $232,499; to **Chase Construction Co.** and **Webb Boone Paving Co.**, of St. Louis, for $509,471. In Massachusetts, **E. H. Lewis**, of Andover, Mass., bid $860,125 for a cement concrete and bituminous macadam job. **Lewis & Frisinger Co.**, of Ann Arbor, Mich., obtained a state highway contract for $290,498. Nebraska awarded contracts to **Western Asphalt Paving Corp.**, of Sioux City, Iowa, for $771,447 and to **Abel Construction Co.**, and **Thiesen Bros.**, of Osmond, Nebr., for $363,074. In Erie County, N. Y., **Brayer Bros. Construction Co.**, of Buffalo, N. Y., bid in a $205,621 project. A road mix bituminous surface treatment project in California went to **J. Granfield-Farrar & Carlin**, of San Francisco, for $326,255.

AND WHO'S DOING THEM

CONSTRUCTION—
Still a Made-to-Order Industry

A RECENT discussion of the construction industry and its problems includes this significant statement: "In terms of its finished product, construction is principally a *non-duplicating* industry." The italics are by this writer. They are intended to emphasize a condition not always understood by business men, public officials, journalists and others who, on one occasion or another, may have to deal with the industry.

For several reasons it is not feasible to apply to construction the same standards of industrial practice that may apply to the farm, the mine or the factory. Yet we frequently see its problems lumped for discussion with those of other industries; analogies often are drawn between construction and other industries that have no foundation in fact. In the interest of more general understanding of such distinctive conditions this page, from time to time, will discuss some of them and try to interpret their significance. For this month, let us have a look at this matter of "non-duplication."

Many industries have found it possible to reduce their operations to a series of repetitive processes. They design standard products to be produced in large quantity; then they set up fixed and permanent plants designed to perform those repetitive operations most efficiently. This was not always so. Once the factory-made product was made to order, sometimes by hand, more often with the limited aid of simple machinery. But today, mass production is a characteristic of American industry; the standardized product and its repetitive production are its basis.

ALL THIS, however, has little significance in construction practice. Construction is still chiefly a made-to-order industry. It is true that some basic processes such as excavation, concrete-mixing and materials-handling may, on large jobs, lend themselves to mass production methods. But even here, the operating conditions, the character of materials and other circumstances may be so diversified or variable as to prevent the processes from becoming so routine as in factory practice. And while each of these processes is in itself highly important, all are but parts of the ultimate product of the industry. That is the finished structure, not merely yards of excavation or tons of steel.

It is true, then, that each construction product must be measured, laid out and cut to fit; it cannot be a ready-made affair. The engineer must design each structure to fit special needs at a particular site; he cannot pull a ready-made design from a catalog. The constructor must lay out his plant and organize his staff to build that product at that site, which precludes routine or repetitive conduct of the construction function. Apart from a few basic processes, construction cannot be put on a mass production basis; it must remain for the most part a custom operation.

That is the very reason why a journal such as *Construction Methods* has come to win so significant a place for itself. It is the natural answer to those conditions. To the men in the field it brings periodically a selection of actual examples to show them how other constructors have combined plant, staff and method to create some construction product. It recognizes that to them each job is a new problem and that no standard overall solution can be expected to fit exactly any given case. It knows that duplication and repetition have relatively small place in the conduct of construction.

SO IT SEEKS by constant review and analysis of work done to help its readers develop those qualities of knowledge, experience and judgment that are so necessary in their work. It illustrates in as precise detail as possible how equipment, organization and methods actually have been applied to the various elements of specific jobs. As in military practice, where every problem also is special, the qualities necessary for success are a wide knowledge of how other jobs have been licked, an understanding of the principles and practice that licked them, resourcefulness in sizing up the job in hand and picking the right answer and a shrewd judgment of plant and human capacities under variable conditions.

These are the qualities required of the competent operator in any *non-duplicating* industry; they always will be characteristic of the successful constructor. Standardization of thought and practice, duplication of product, repetitive processes; these are not so likely to thrive in the construction atmosphere.

Willard Chevalier

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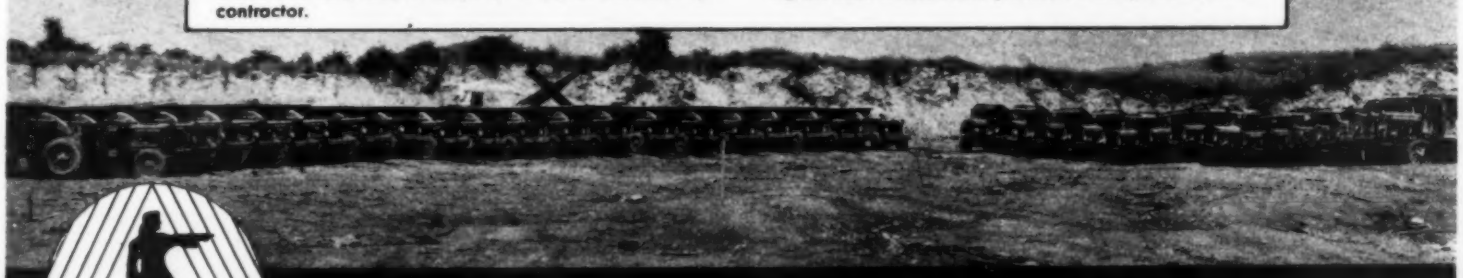
Convincing Evidence!

TRAC-TRUK
PERFORMANCE AND VALUE IN BIG FLEETS OWNED BY EMINENT CONTRACTORS

These two instances, selected at random, are typical of the expanding Trac-Truk fleet ownership and operation on scores of the more important construction projects. In each of these cases the fleets increased quickly to their present proportions —as more hauling equipment was needed—after full satisfaction was experienced with an initial trial purchase. Such illustrations of extensive and distinguished use as are pointed out here, afford the best possible proof of equipment value and unbiased evidence of superior performance.

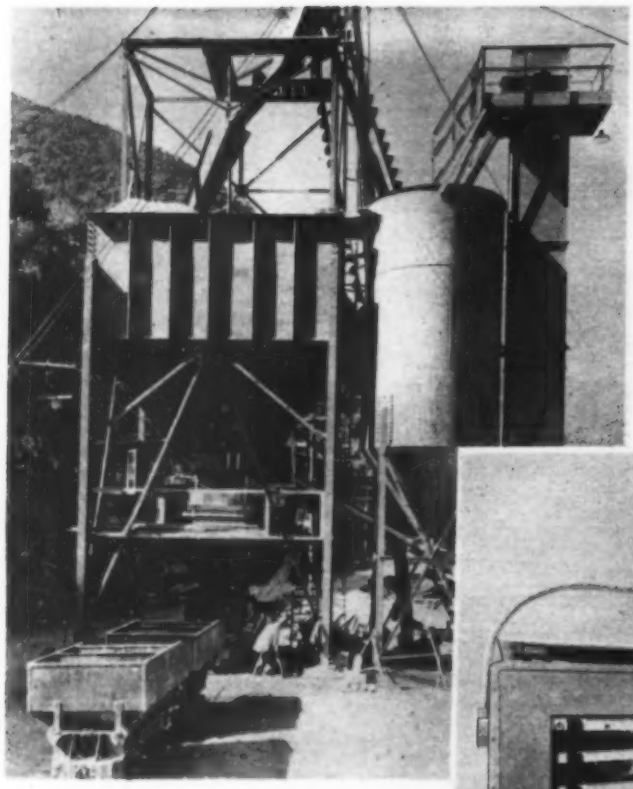
Above—The Mohawk Ohio Dam Construction is exceptional in magnitude and so is the extensive operation of Trac-Truks shown here as used by Geo. M. Brewster & Son, Inc., of Bogota, N. J., an outstanding contractor.

Below—These 20 Bottom Dump and 16 Rear Dump Trac-Truks were selected by Arthur A. Johnson Corp., for moving the 7,000,000 yds. of fill material in preparing the next World's Fair grounds on Long Island, N.Y.



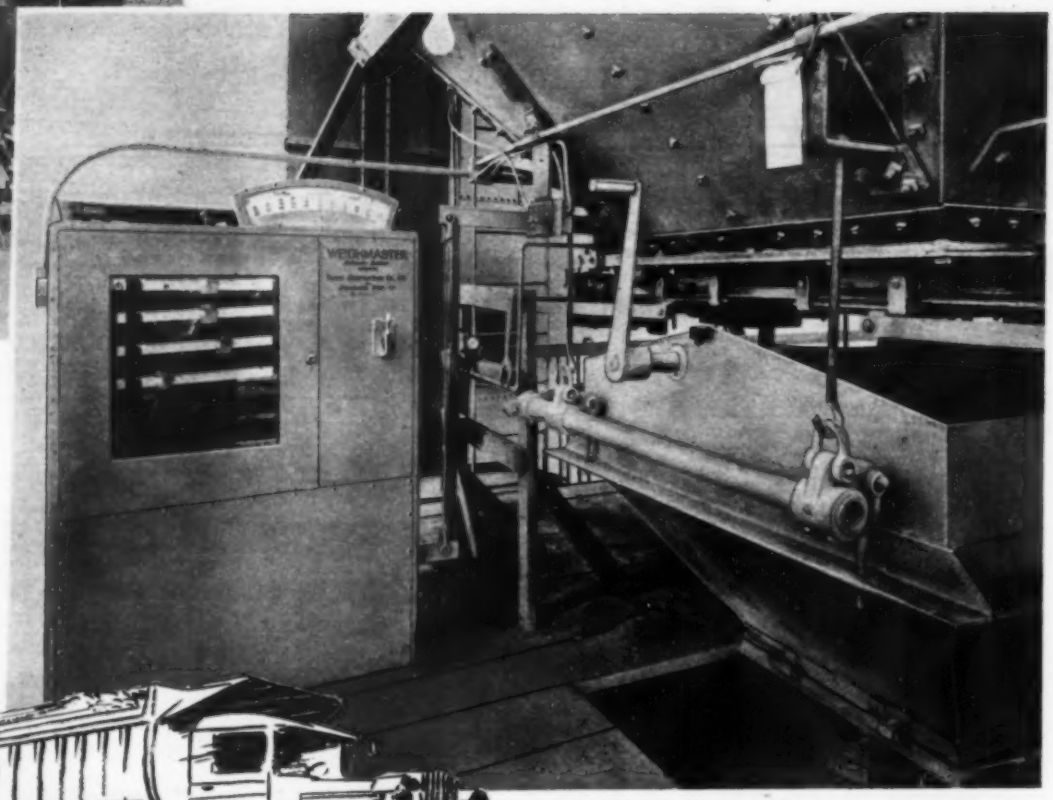
EUCLID
THE PIONEER

THE EUCLID ROAD MACHINERY CO.
CLEVELAND, OHIO U. S. A.



G-E Electric Eye

Speeds Batching, Assures Perfect Mix



This automatic weighing batcher, controlled automatically by G-E photoelectric-relay equipment, is a big time and money saver on the Southern California Metropolitan Aqueduct. Machine built by Standard Steel Works, Los Angeles

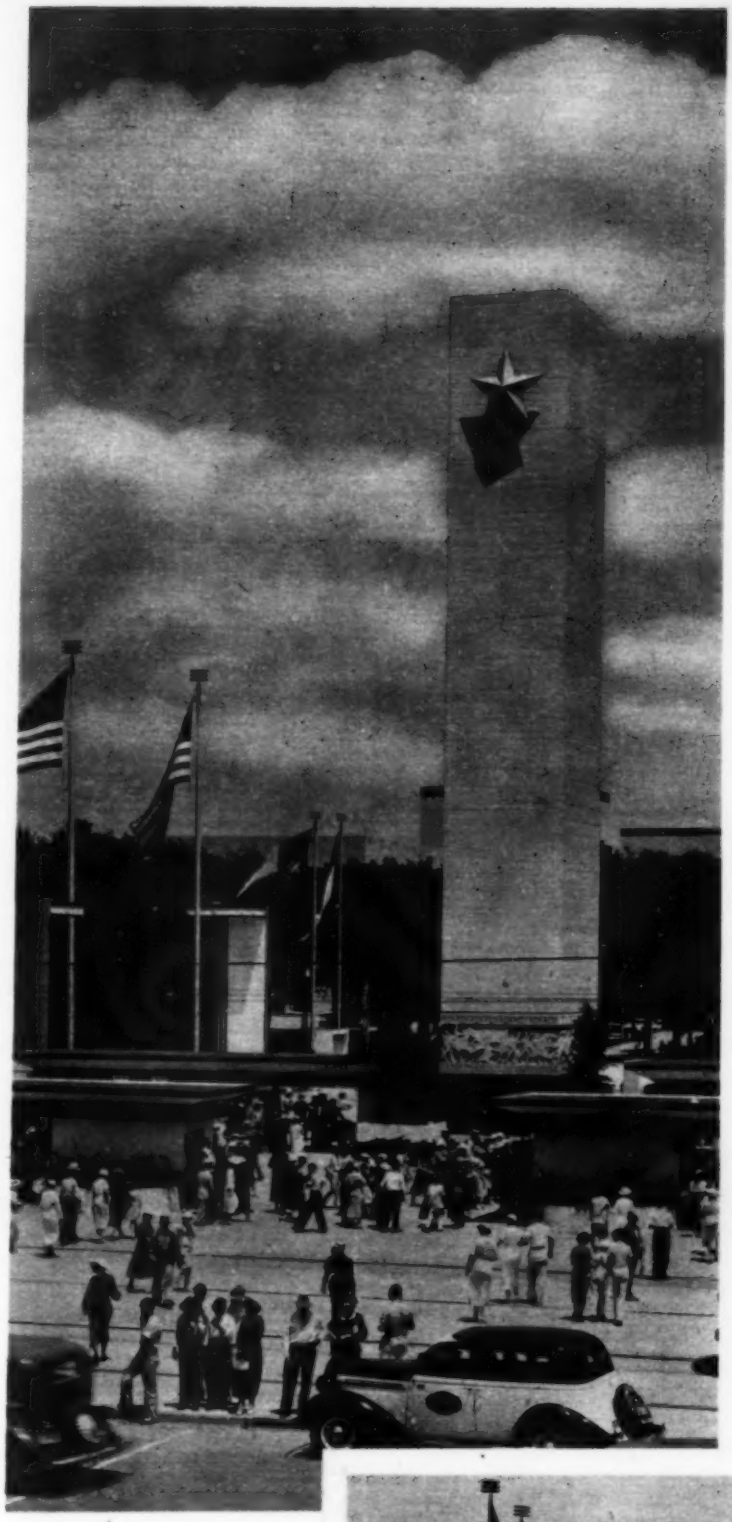
G-E photoelectric-relay equipment applied to the "Weighmaster" makes possible unusual speed, full-automatic operation, and perfect mixing in large-scale cement and aggregate batching.

With this machine, as much as 5000 pounds can be weighed with Bureau of Standards precision in 25 seconds. On the Southern California Metropolitan Aqueduct, 23 of these machines weighed 15 to 25 carloads of cement and 20,000,000 to 30,000,000 pounds of aggregate per day.

It will pay you to investigate the advantages of using G-E equipment on your projects. General Electric, Schenectady, N. Y.

YOU GET SPEED FOR THE JOB, MORE SERVICE FOR YOUR MONEY, WHEN YOU USE G-E EQUIPMENT

GENERAL ELECTRIC



TEXAS TAKES A BOW

'Incor' Reduces Cost of Top-Speed Schedules in Erecting Exposition Buildings

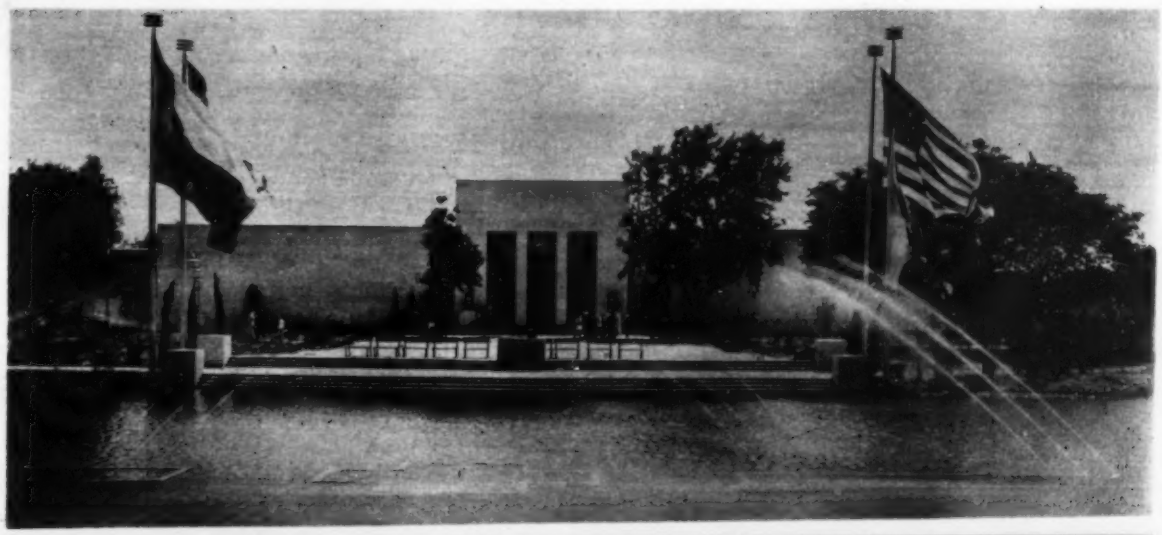
THESE days it isn't news when engineers and contractors break records for speedy construction. But it *is* news when, in straining and crowding to save every possible minute, money is also saved. And that is precisely what 'Incor' 24-Hour Cement helped to accomplish in speeding completion of ten Texas Centennial buildings at Dallas. For example:

In the 60' monolithic tower (left) and five sets of entrance gates, 'Incor' provided working strengths at least five days sooner than ordinary concrete on each pour. 'Incor' piling for the Hall of State or Texas Building, cast and driven during late Fall, overcame cool-weather curing delays, reduced from costs, saved many days on driving schedule.

To illustrate what these savings mean when translated into hard, cold cash on a typical 'Incor' job, details are given (at left) showing a $2200 *net* saving on the Exposition's Museum of Fine Arts Building. Faster schedules with 'Incor' at lower cost have helped to solve many an emergency problem. But it goes much deeper than that; for 'Incor'* usually saves money on any job—whether rush or not — by canceling out non-productive time waiting for ordinary concrete to harden. For details, write for free copy of new book entitled "Cutting Construction Costs"—address Lone Star Cement Corporation (subsidiary of International Cement Corporation), Room 2203, 342 Madison Avenue, New York, N. Y.

*Reg. U. S. Pat. Off.

$2200 SAVED WITH 'INCOR': *Contract for Museum of Fine Arts Buildings (right) was awarded Jan. 31; completion by June 1 guaranteed under penalty. Using 'Incor,' the contractor stripped forms from first half of floor slab in two days, re-used forms for second half. That saved an extra set of forms — lumber worth $1250, plus $300 for labor. In addition, 'Incor' saved 10 days overhead costs, at $100 a day, or $1000. Total 'Incor' saving, $2550. Extra cost of 'Incor,' $272.70. Net saving, $2277.30. That's taking the high cost out of speed! But the same principle applies even when time schedules are normal. Estimate your next job with 'Incor' and see what these savings mean in real cash money.*



'INCOR' 24-Hour Cement

Scene from Warner Bros. picture "Earthworm Tractors" starring Joe E. Brown with June Travis and Guy Kibbee, based on stories about Alexander Botts, Earthworm Tractor Salesman, by William Hazlett Upson, published in The Saturday Evening Post. ("*Caterpillar Diesel Tractors*" were used).

"Earthworm Tractors" and Inland Steel Star with Joe E. Brown

Joe E. Brown's latest comedy, "Earthworm Tractors", demonstrates the reason why "Earthworm Tractors" are so popular in such rough-and-ready industries as logging, mining, construction, etc. In showing their own amazing strength and stamina, "Earthworm Tractors" also testify to the quality of Inland Steel, for Inland Steel is used extensively in the building of these machines.

Inland has worked with "Earthworm" for many years, supplying an increasing tonnage of bars, shapes, plates, and sheets to keep up with the growing demand for these powerful tractors.

The well-known Inland *Safety* 4-Way Floor Plate is shown in the smaller photograph at the right.

This is typical of the co-operation and service Inland is giving to many builders of world-known products. Call an Inland Engineer for a discussion of your steel requirements.

SHEETS • STRIP • TIN PLATE • BARS • PLATES • STRUCTURALS • PILING • BILLETS • RAILS • TRACK ACCESSORIES

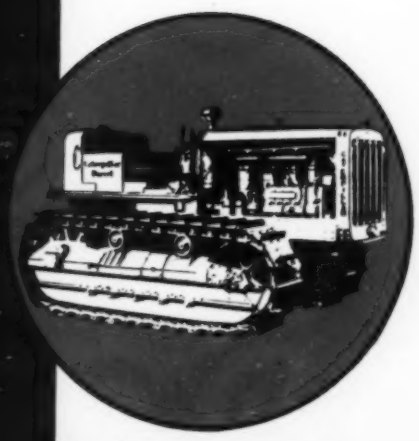
INLAND STEEL CO.

General Offices: 38 South Dearborn Street, Chicago, Illinois

WHEN IS IT TIME TO TRADE IN YOUR PRESENT MACHINE?

If you are now using a gasoline tractor or motor grader, right now is the time to replace it with a "Caterpillar" Diesel. Its tremendous savings in fuel costs—its low maintenance costs—its power and endurance—are fast obsoleting other forms of power. Today's jobs demand the "Caterpillar" Diesel. You can't do today's jobs with yesterday's power—not if you want minimum costs.

More than 15,000 "Caterpillar" Diesels—tractors, motor graders and engines—are already in use. The number is fast increasing. Resale values of used gasoline tractors have dropped—seem certain to drop further. Replacement now gives you two important advantages—you begin immediately to enjoy the savings of "Caterpillar" Diesel power—you avoid further obsolescence loss on your present equipment. See your dealer for the SHOW-DOWN on this question. Caterpillar Tractor Co., Peoria, Ill., U. S. A.



CATERPILLAR

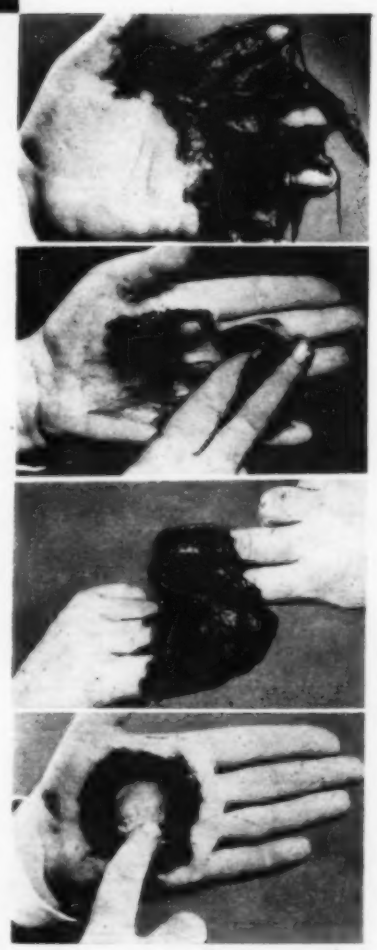
DIESEL

TEXACO-TRAINED

When he says: "You can reduce break-downs" he proves it!

The Texaco-Trained man is a specialist in Lubricants. He knows their application to your equipment.

MARFAK will s-t-r-e-t-c-h, as shown, proving its unique cohesiveness and adhesiveness. Try to make this demonstration with any other lubricant. None withstands this test like Marfak.



MARFAK clings to bearing surfaces the way it clings to your fingers. It resists channeling. Ordinary greases channel easily and permit metal-to-metal contact.

AN EVEN BETTER test is to smear a little Marfak on a smooth surface and then try to rub it off again. Compare it with any grease you have ever used.

IN A GREASE-TYPE UNIVERSAL, centrifugal force throws off most greases. Marfak has load carrying strength—because it contains heavy dewaxed cylinder oils.

UNDER A REVOLVING LOAD, such as occurs in a bearing under rolling action, Marfak liquefies and supplies a fluid film, and seals the film on bearing.

WHEN a Texaco-Trained man calls on you, he knows the requirements of heavy contractors' equipment, the stress it puts on lubricants, the various types of lubes that will make good in this tough service, and how to apply them for highest efficiency.

He can demonstrate in advance the qualities of his products and explain how they meet your specific operating conditions.

In the case of Texaco Marfak these tests prove that this product lasts twice as long as ordinary lubricants and seals the bearing on the outside against leakage and contamination.

Ordinary grease cannot compare with Marfak in providing protection for contractors' equipment, including motor trucks. Ordinary grease squeezes out, washes away, permits rapid wear—sets the stage for break-downs.

The Texaco-Trained man will be glad to provide practical engineering service to prove the economies of Texaco Products.

THE TEXAS COMPANY
135 East 42nd Street, New York City
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TEXACO *Industrial Lubricants*

ANNOUNCING..

Speed-o-Matic

Effort-less

CONTROL

for

SHOVELS • DRAGLINES • CRANES

THE BIGGEST NEWS FOR THE MATERIALS HANDLING FIELD IN YEARS

OPERATOR FATIGUE
Banished forever!

Comfortable Seat for Operator

AS EASY AS DRIVING A CAR

Link-Belt Speed-o-Matic Control assures maximum speed and output from shovels—draglines—cranes. The operator is comfortably seated in full view of the work. Operation is as simple and easy as driving an automobile.

POWER CONTROL vs. MANUAL OPERATION

Speed-o-Matic Control does two things: It eliminates operator fatigue and increases the operating speed of the machine. The combination of these two advantages tremendously increases the output of the machine and reduces handling costs, permitting the operator to attain and maintain top efficiency. Naturally this also increases the efficiency of trucks and other auxiliary equipment used on the job.

The increased production, resulting from Speed-o-Matic Control, will often permit the use of a smaller, less costly machine than would otherwise be required.

With Speed-o-Matic Control, the functions of the machine respond quickly, and although the effort required is but a fraction of that of the mechanical lever system, the operation is extremely smooth.

RELEGATES BACK-BREAKING LEVERS TO THE HORSE AND WAGON DAYS

No longer need the operating speed of shovels—draglines—cranes be dependent on the physical limitations of the operator's endurance. Speed-o-Matic Control transfers the work of operation, from the operator to the power of the machine itself. The handles and pedals have a short, easy throw, permitting rapid and smooth acceleration and deceleration of the several functions of the machine. Short, easy, wrist motions move the control handles, and the short-throw foot-pedals are operated from a sitting position. This is in striking contrast with the operation of the old mechanical levers, which are not only slow, but which reduce the efficiency of the operator hour by hour.

CLUTCH AND BRAKE "FEEL"—IDEAL

The smooth, easy, natural "feel" of the clutches and brakes gives the operator perfect high-speed control of the machine.

AD NO. 5808

ANOTHER LINK-BELT ACHIEVEMENT

Link-Belt Speed-o-Matic Control takes its place with scores of other Link-Belt engineering achievements as probably the most revolutionary development since the introduction of the crawler shovel-dragline-crane. Not only does this perfected control reduce costs—making top machine efficiency possible—but because of its simplicity, less maintenance is required. There are really no wearing parts, as the actuating mechanism is oil immersed and practically all of the parts which cause the most trouble in the conventional lever-control system are eliminated.

AMAZING RESULTS ASSURED

Speed-o-Matic Effort-les Control results in outputs so greatly increased, that claims based on actual data would appear extravagant. A visual demonstration is necessary for an appreciation of the astonishing results that are now obtainable.

PROVED IN THE FIELD

Link-Belt Speed-o-Matic Control is announced after nearly four years of development work, and exhaustive tests in the field for over a year, under actual working conditions. A comparison of the output of Speed-o-Matic Control units with those of like-size lever controlled machines, has proved their astonishing ability to provide greater output and thereby cut costs. See chart on last page.

BELT

o-Matic

FFORT-LES CONTROL

OR SHOVELS—DRAGLINES—CRANES

AINTAINS TOP EFFICIENCY

PEEDS UP THE JOB

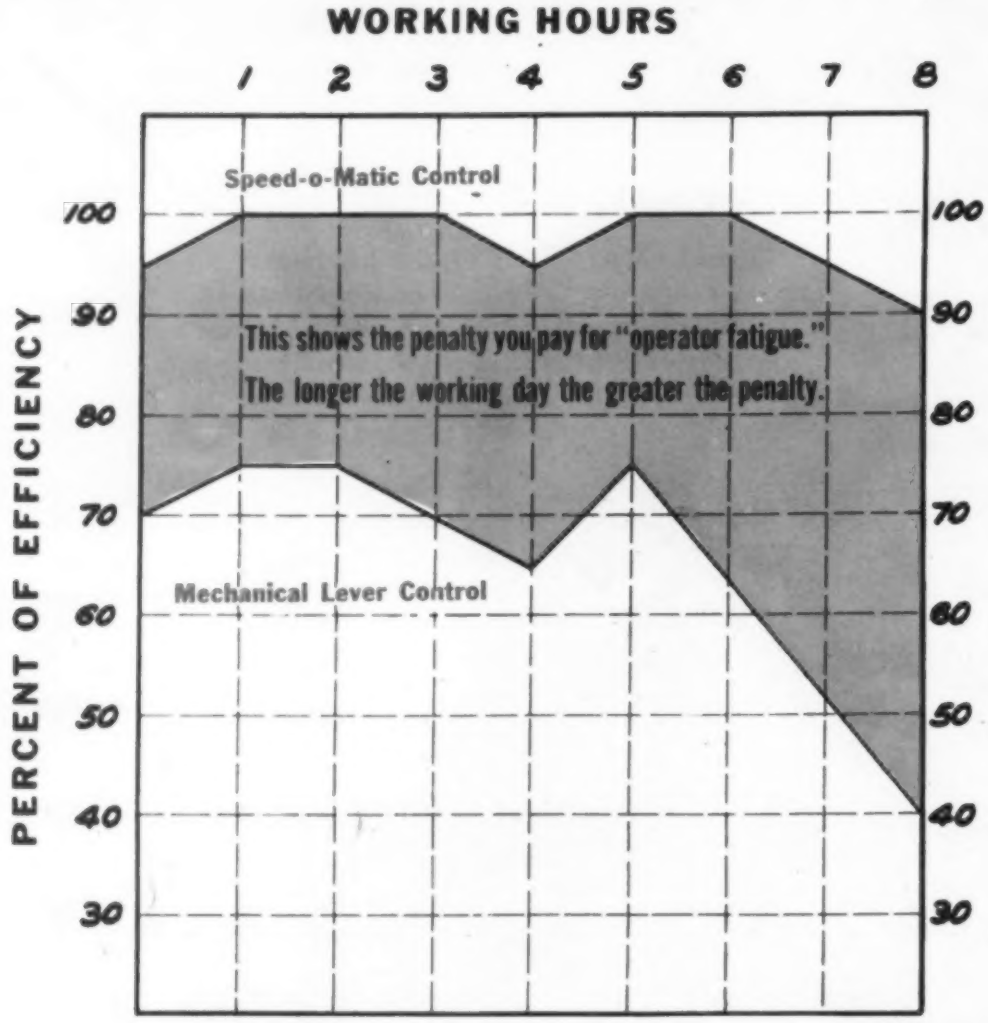
ICREASES OUTPUT

EDUCES COSTS

YOUR NEXT SHOVEL • DRAGLINE • CRANE IS CERTAIN TO BE A

LINK-BELT *Speed-o-Matic*

THE PENALTY OF "Operator Fatigue"



The chart shows the relative efficiency of the Speed-o-Matic controlled and mechanical-lever-controlled machines, assuming maximum efficiency of each.

The top curve which is that of the Speed-o-Matic machine shows a much higher maintained efficiency than the lower curve which indicates the natural inefficiency of the mechanical-lever-controlled system

With SPEED-O-MATIC POWER CONTROL

Sitting in a comfortably cushioned seat with a back-rest (adjustable to height and distance) and operating easy short-throw levers and pedals, the operator exerts the minimum of physical effort. He is not subject to efficiency-destroying fatigue and is thus able to maintain the greater speed of which the Speed-o-Matic machine is capable and secure vastly increased output.

With MECHANICAL LEVERS

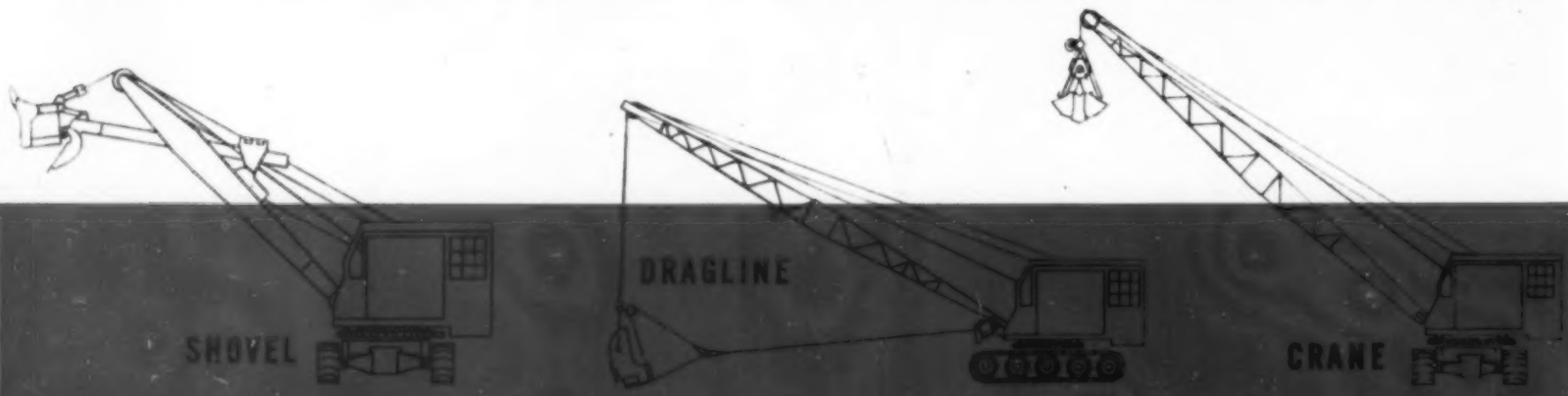
The levers and pedals of the conventional control system have a long, hard throw, requiring an extremely fatiguing shoulder motion and maximum hip action. This inherently slower operating speed and excessive physical effort are the limiting factors in production, and definitely rob the machine of a substantial part of the output of which it would otherwise be capable.

After the Day's Work:

"Nice going, Mac. We're breaking all records."

"We ought to, Chief, with this new Speed-o-Matic — and I feel like a million."

See These NEW LINK-BELT MODELS . . SPEED-O-MATIC EFFORT-LES CONTROL STANDARD EQUIPMENT



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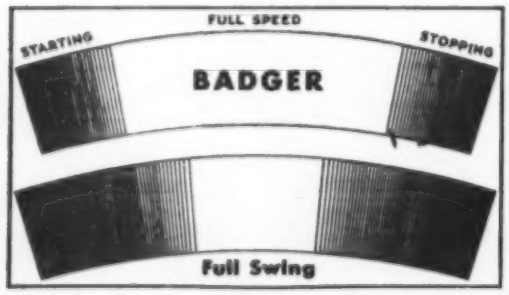
Start, swing, stop

AS FAST AS YOU LIKE...

...that's the Secret of the Badger's *greater output!*

● Once you operate a Badger, you too will understand its greater output

The instant response to controls—its powerful smoothness—its eagerness and ability to gain an extra dipperful will amaze you! Gone is the time-consuming lag and inertia you have associated with big production shovels. You can start, swing, stop as fast as you like! And *that* is the secret of the Badger's greater output.



The actual gain in speed is shown in the diagrams at the left and is achieved through many mechanical advances including special light weight alloy steels, scientific redistribution of weight, the elimination of tail swing, etc.

The Badger is built to be faster. The motor does not swing with the boom. Boom, dipper and dipperstick are of special light weight alloy steel to permit full ½ cubic yard dipper capacity and still save weight. 41 anti-friction bearings forward of motor transmission. Transports at motor truck speeds on its own wheel mounts.

Write today for New Bulletin on the Badger Shovel.

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Use

GULF DIESEL OILS

for low operating costs on tough jobs!

For every type of Diesel equipment you operate, a Gulf engineer will recommend the lubricant which will keep maintenance costs at lowest levels possible.

MANY operators of equipment like that shown above have established this important fact: Over-all operating costs usually have a direct relationship to the efficiency of lubrication. With Gulf Diesel Oil in service many operators are reporting the lowest costs in their experience.

Gulf Diesel Oils stand up over long periods of service—cost less to use in the long run. These quality lubricants have been scientifically manufactured to provide maximum protection for cylinders, pistons and bearings—with low consumption. They will help you keep maintenance costs at a low level.

5 REASONS...
Why Gulf DIESEL OILS Reduce Operating Costs

1 GULF DIESEL OILS are especially manufactured for lubrication of Diesel engines. High temperatures, contamination with fuel and moisture and constant churning in the presence of air—all encountered in Diesel engine operation—necessitate the use of an oil especially prepared to withstand these conditions.

2 GULF DIESEL OILS insure minimum wear of cylinders, pistons and bearings. The tough film provided by GULF DIESEL OILS is not readily removed from the cylinder walls and pistons, insuring proper lubrication of these parts at all times.

3 GULF DIESEL OILS insure minimum consumption. Because they are made from specially selected crudes and manufactured by the most modern refining methods, GULF DIESEL OILS withstand the high temperatures encountered in Diesel engine operation. A minimum of make-up oil is required.

4 GULF DIESEL OILS reduce operating costs. Because of the stability and high lubricating quality of these oils, wear and repair expense are minimized. Lower oil consumption and lower maintenance costs reflect substantial savings in over-all operating costs.

5 GULF DIESEL OILS are low in carbon content—a safeguard against carbon deposits resulting from the lubricating oil. With good atomization of fuel and complete combustion, rings retain their freedom. Thus, the oil contributes to full power and operating efficiency.

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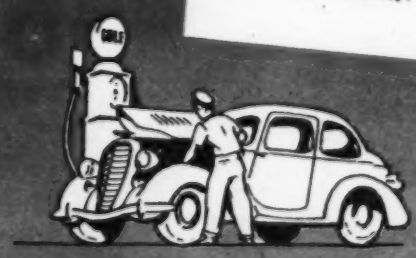
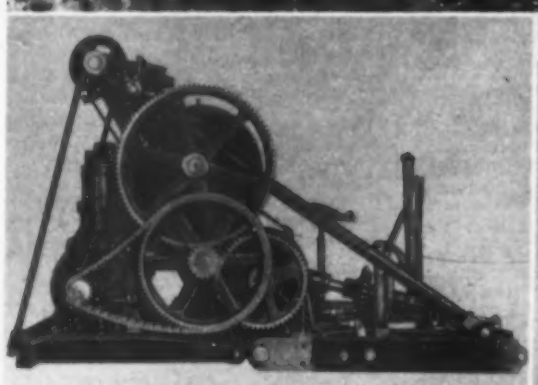


Makers of
that Good Gulf Gasoline and Gulflube Motor Oil

¾ yd. LORAIN 40

THERE IS NO OTHER MACHINE LIKE IT ON THE MARKET



★ BECAUSE no other machine has the sloping machinery frame (patents applied for) which is the greatest single factor in enabling the Lorain-40 to handle a ¾ yd. dragline bucket or shovel dipper at a working weight and price approximating those of most ½ yd. machines . . . The new L-40 bulletin gives plenty of reasons why the Center Drive built L-40 is the fastest selling ¾ yd. machine in the world today. Write for it.

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LORAINS

MOVE MORE MATERIAL, FASTER AT LOWER COST

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Harlem Boulevard, Rockford, Ill. Tarvia-built in 1922. The slightly granular surface of the road is as effectively skid-safe today as it was fourteen years ago.

Barrett

TARVIA

GOOD ROADS AT LOW COST

Today, more than ever, the need is for *skid-safe* roads. Modern high-speed automobiles, quicker braking and greatly increased traffic place a heavy responsibility upon highway builders. No special method is necessary to make Tarvia roads lastingly skid-safe. Tarvia penetrates deeply, holding the stone or gravel firmly exposed on the road surface to give tires an effective grip that minimizes the skid hazard. Ask the Tarvia field man about it.

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Give Tru-Lay Preformed a chance to prove itself on *your* job. Learn by experience what multiple savings may be gained through this rope that lessens machine shut-downs, is easier, faster and *safer* to handle.

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TRU·LAY *Preformed* Wire Rope

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INSIST ON:

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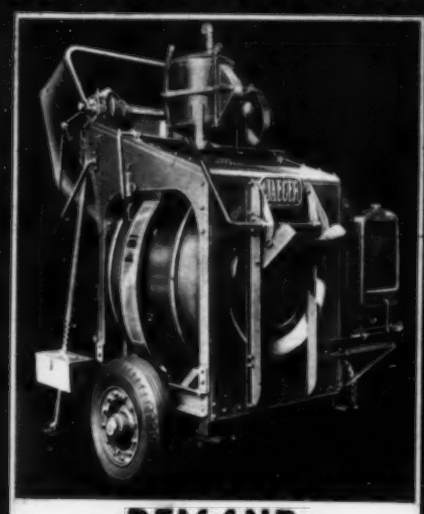

DEMAND:

- Faster Charging and Discharge Speeds,
- Machined Steel Tracks,
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- End Discharge Advantages,
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JAEGER TRUCK MIXERS CUT YOUR COSTS:

- High Production,
- Small Investment,
- Direct Discharge into Forms,
- Better Concrete,
- No Material Piles or Water Lines,
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LAYING BLACK TOP?

JAEGER PAVER has 10 ADVANTAGES:

- 18 Ft. Movable Forms Give Smoothness of Concrete,
- 50% More Traction,
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- Adjustable 9 to 14 Ft. Widths,
- Blends Perfect Joints,
- Capacity to 1000 Tons a Day,
- Lays Hot or Cold Bituminous, Stone or Macadam,
- Pug Mill Spreader,
- Less Hand Finishing,
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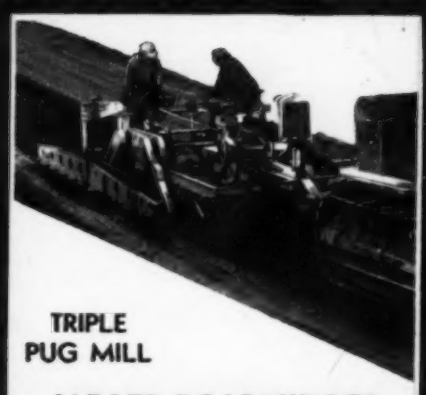
MIX-IN-PLACE ROADS



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JAEGER ROADBUILDER MIXES IN ONE PASS:

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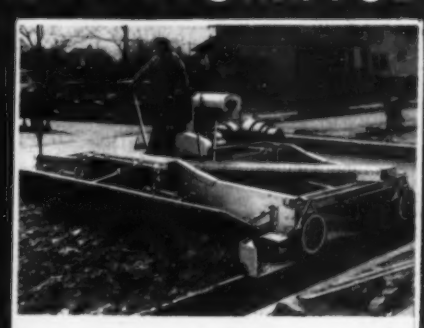

JAEGER-LAKEWOOD Automatic FINISHER:

- For Concrete or Bituminous,
- Flexible as Steam,
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- Telescopic Width Changes,
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Millions of new construction dollars are earmarked for builders familiar with

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Competition among contractors for more and more new buildings will be limited to those who understand the latest technique in architectural concrete. Fore more and more architects and building owners alike know exactly what they want — and it's concrete!

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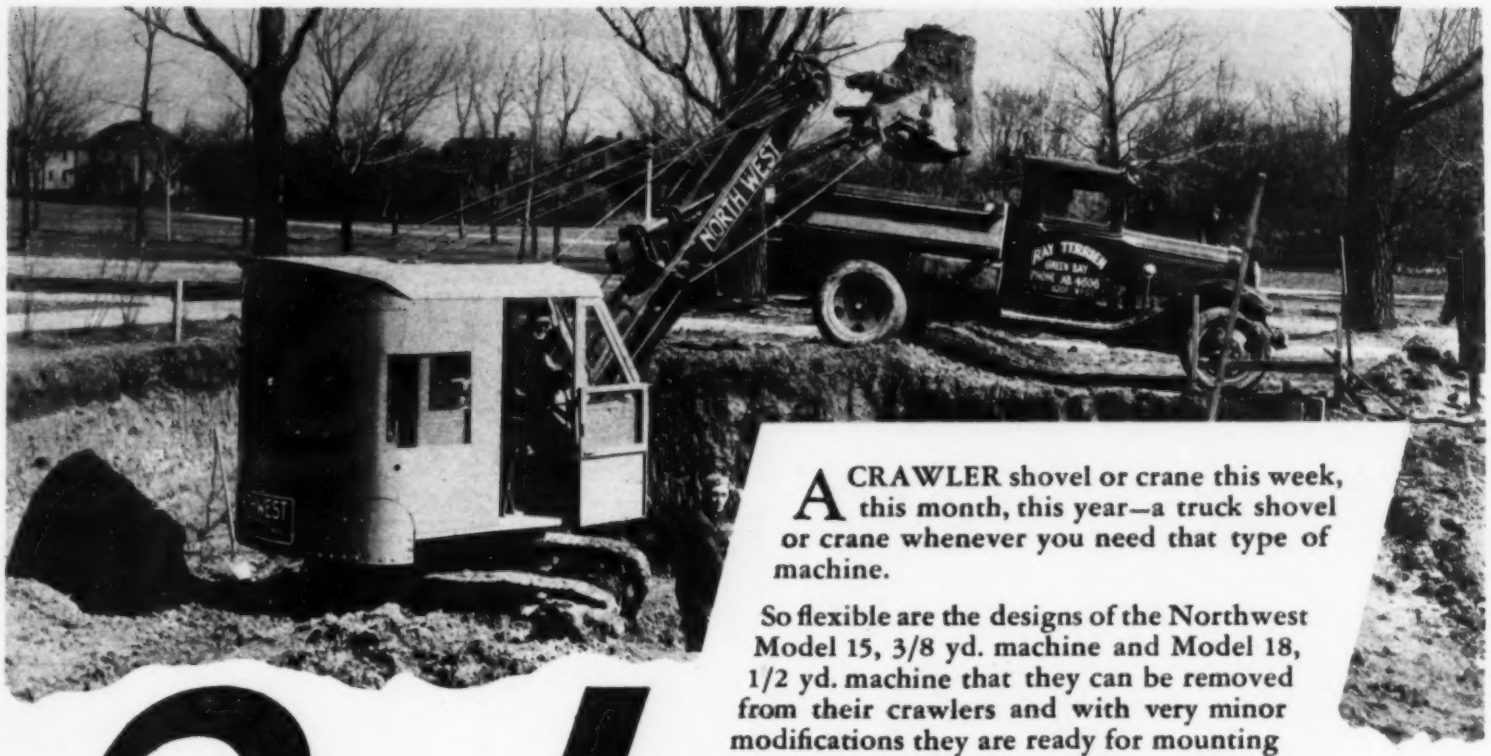


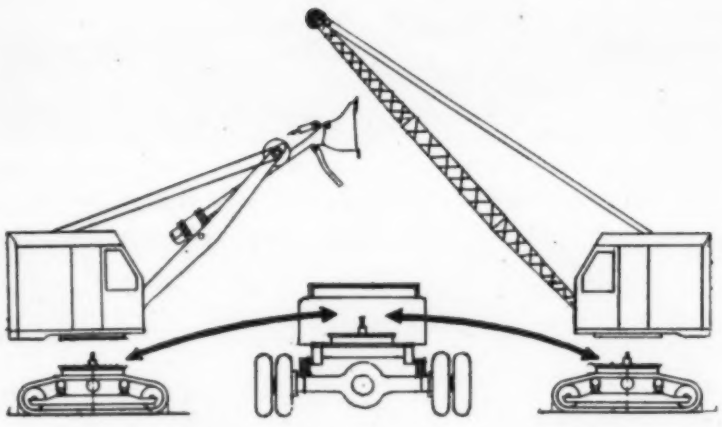
A CRAWLER shovel or crane this week, this month, this year—a truck shovel or crane whenever you need that type of machine.

So flexible are the designs of the Northwest Model 15, 3/8 yd. machine and Model 18, 1/2 yd. machine that they can be removed from their crawlers and with very minor modifications they are ready for mounting on a truck chassis giving that mobility that only a truck mounting can give.

Thus with a basic machine, a shovel boom, a crane boom and a truck you are equipped to meet every possible condition.

And this is only one of many advantages of Northwest Model 15 and 18 machines.

2 in 1 SUPER-MOBILITY



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The world's largest exclusive builders of gasoline, oil, diesel or electric powered shovels, cranes, draglines, pullshovels and skimmers

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BUILT IN A RANGE OF 15 SIZES

NORTHWEST

3/8 YARD CAPACITY AND LARGER

"O.K. Mac! WE'RE SHIPPING TODAY"

This is J. H. Kempster, general superintendent of our Buffington, Indiana, plant.

Mac—salesman on the other end of the line, has asked for an "impossible" bit of service—but he's going to get it!

● We get a big kick out of coming through on tough service assignments. And that goes for all departments. Naturally, we think we can serve you best when we have a little time to fill your request in the course of the ordinary day's routine. But when a real emergency arises, whether it be a rush call for cement or facts on cement, we try our level best to get it to you in double-quick time.

Of course our motive is a selfish one. We think that giving you a little better service will help us sell more cement.

G-3

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208 South La Salle Street, Chicago

United States Steel — Corporation Subsidiary

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Universal Atlas
CEMENTS

Construction Methods

Established 1919
McGraw-Hill Publishing Company, Inc.

Volume 18 Number 9

September, 1936

ROBERT K. TOMLIN, Editor

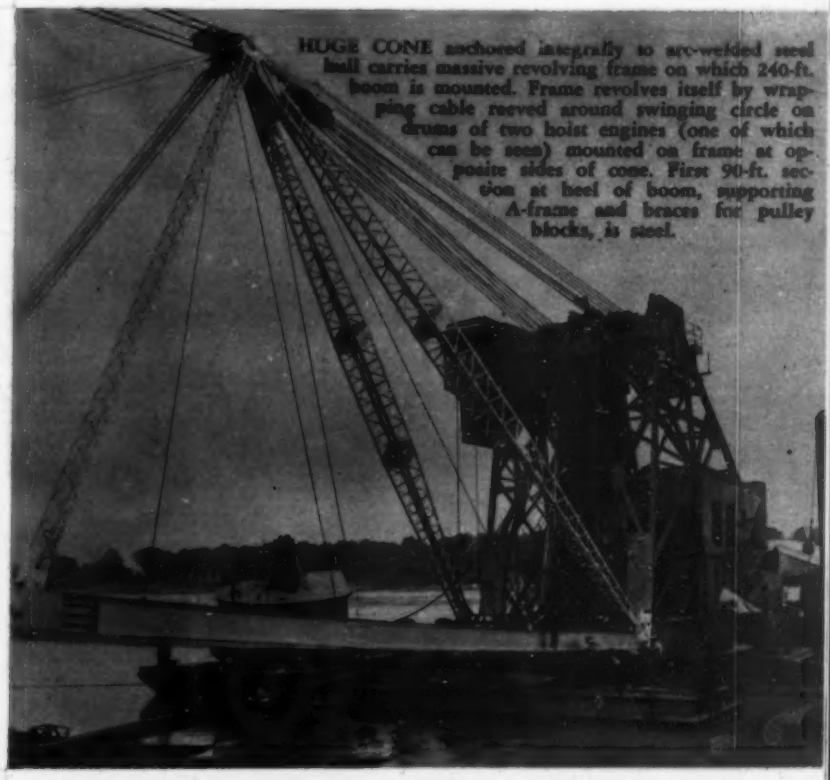
1,750-TON DREDGE designed to handle 6-cu.yd. clamshell bucket at end of 240-ft. aluminum and steel boom leaves St. Louis in tow for Belle River, La., where it now is building levee along Atchafalaya floodway.

CLAMSHELL DREDGE

With 240-Ft. Boom

Builds Atchafalaya Levee

A MAMMOTH diesel-electric clamshell dredge capable of swinging a 6-cu.yd. bucket through a 180-deg. arc of 250-ft. radius in ½ min. is building levee on the Atchafalaya floodway of the Mississippi River flood control project for the Sternberg Dredging Co., Inc., of St. Louis. Conceived by H. J. Sternberg, president of the dredging company, and designed and built under his guidance, the great clamshell dredge carries a 240-ft. boom made up of a 90-ft. steel section at the heel and two aluminum sections of 150-ft. total length. The boom is mounted on a massive steel frame which rotates about a giant steel supporting cone built into the arc-welded hull to assure stability. At the right side of the revolving frame, 50 ft. above the deck, is the operator's control cabin.



HUGE CONE anchored integrally to arc-welded steel hull carries massive revolving frame on which 240-ft. boom is mounted. Frame revolves itself by wrapping cable reeved around swinging circle on drums of two hoist engines (one of which can be seen) mounted on frame at opposite sides of cone. First 90-ft. section at heel of boom, supporting A-frame and braces for pulley blocks, is steel.

1,000-HP. DIESEL ENGINE connected direct to main generator and by multiple V-belt drive to auxiliary generator supplies power for operating mammoth clamshell dredge.

Cone, operating machinery and diesel-electric power plant rest on a 150x50x9-ft. steel hull which was electrically welded throughout. A 1,000-hp. Busch Sulzer diesel engine drives the main generator and, through a Worthington V-belt drive, the auxiliary generator. Although the complete dredge, as built in the yards of the St. Louis Shipbuilding & Steel Co., weighs slightly in excess of 1,750 tons, the 240-ft. boom is reported to weigh only 20 tons including A-frame and braces. The boom handles a 6-cu.yd. Williams clamshell weighing 15 tons, specially built of alloy steels and all-welded construction by the Wellman Engineering Co. Loaded with 6 cu.yd. of wet Mississippi Valley gumbo, the bucket weighs more than 24 tons. When swinging through a long arc, the bucket averages about 20 m.p.h. The dredge is reported to have cost approximately $225,000.

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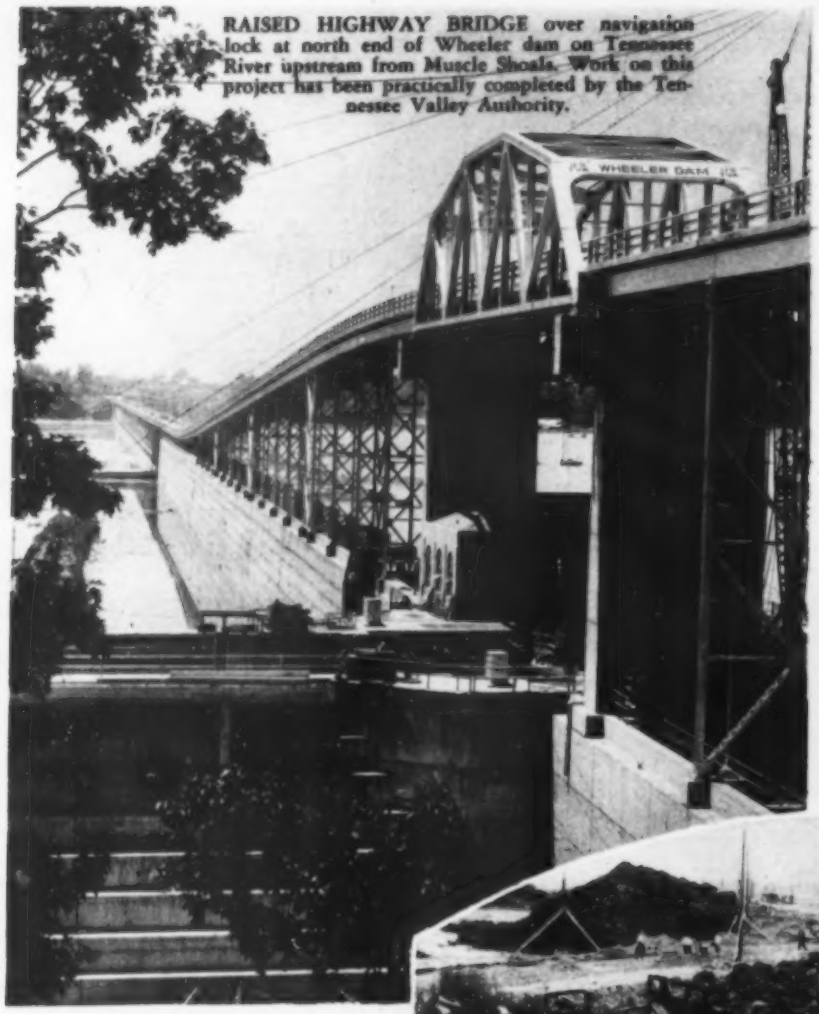
This Month's "NEWSR

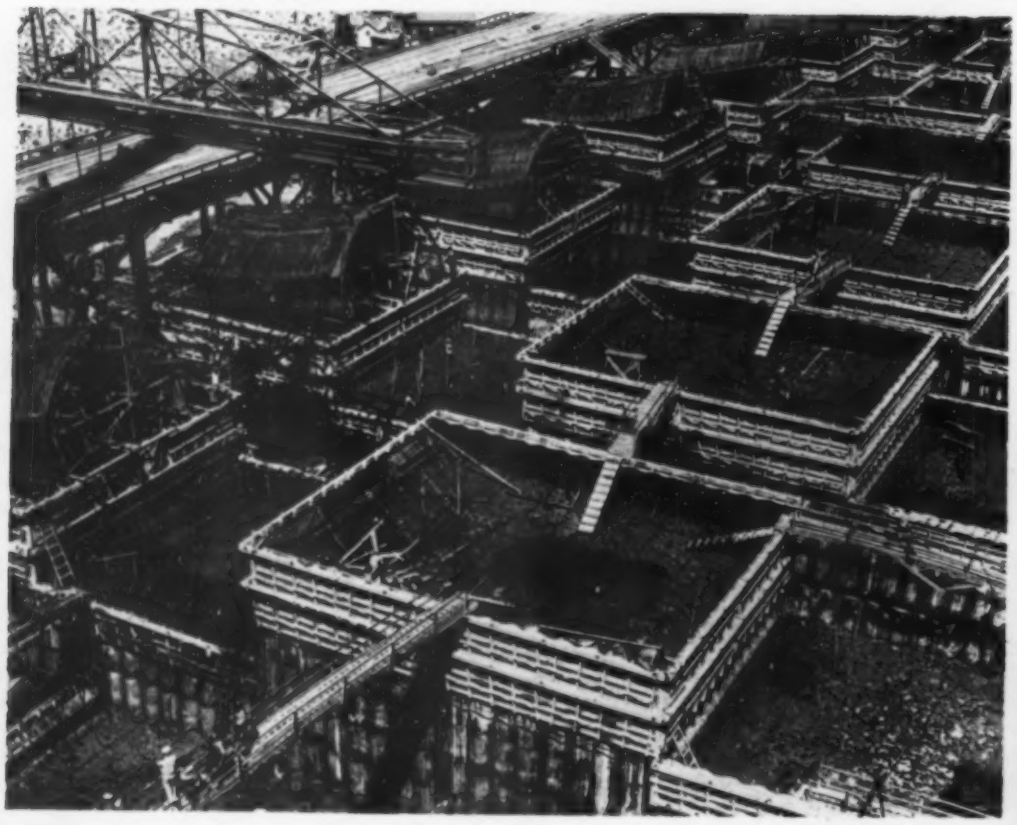


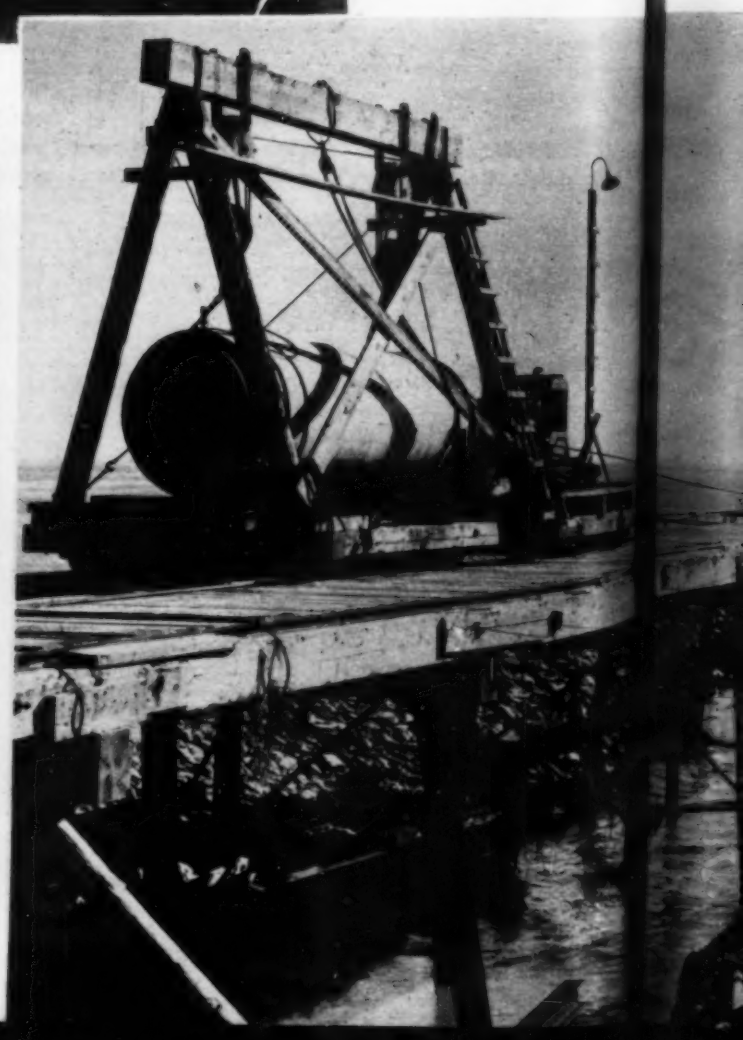
RAISED HIGHWAY BRIDGE over navigation lock at north end of Wheeler dam on Tennessee River upstream from Muscle Shoals. Work on this project has been practically completed by the Tennessee Valley Authority.

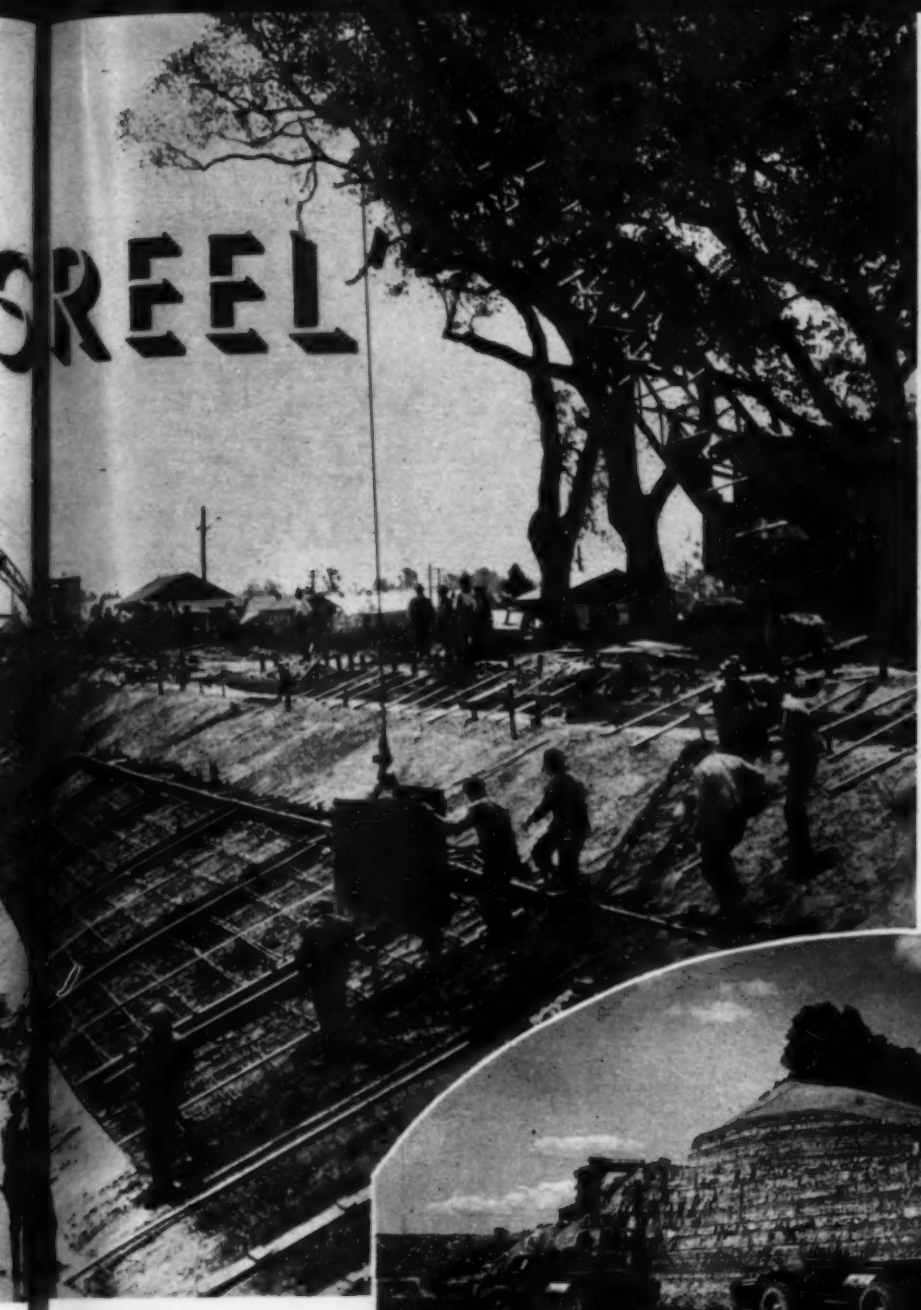
DRAINAGE CANAL is being lined with concrete to deliver New Orleans storm water to Lake Pontchartrain. Project is part of a $2,570,000 program financed by the Public Works Administration.

GRADING OPERATIONS *(right)* on Flushing Meadows, Borough of Queens, New York City, are in progress at site of 1939 World's Fair where Arthur A. Johnson Corp.-Necaro Co., Inc. have a $2,186,185 contract for the movement of about 7,000,000 cu. yd. of earth. View shows Gar Wood bulldozer on tractor leveling off fill dumped by trucks.

HUGE PENSTOCKS *(below)* for delivering water to power house at Grand Coulee dam on Columbia River in Washington are beginning to take shape, under direction of U. S. Bureau of Reclamation. Main body of dam is being built up in form of blocks of mass concrete by Mason-Walsh-Atkinson-Kier Co.



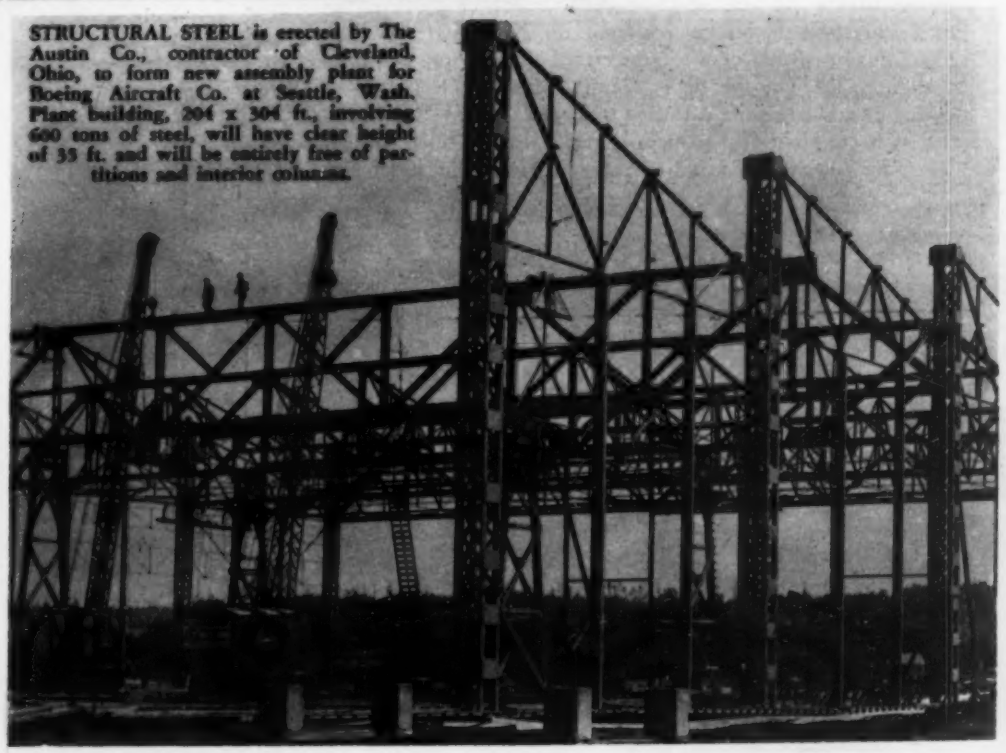




HIGH TIMBER TRESTLE replaces old 8th Street bridge in Port Angeles, Wash. Structure 755 ft. long and 100 ft. in maximum height is supported by two-column bents involving modern developments in timber construction, using 4-in. split-ring connectors.

AT MOHAWK DAM, Muskingum Conservancy project near Warsaw, Ohio, earth excavation and fill are being handled by fleet of 24 Euclid Trac-Truks *(left)*, each carrying 10 cu.yd. and riding on 16-ply, 18.00x24 pneumatic tires inflated to 40-lb. pressure. Contractor for 115-ft. high earth embankment is George M. Brewster & Son, Inc., of Bogota, N. J. Major J. D. Arthur is district engineer in charge of project for U. S. Engineer Department.

PRECAST CONCRETE PIPE sections are placed from trestle to form White Point sewer outfall in Los Angeles, Calif., a $3,000,000 PWA project. The sewer extends along the ocean bed for about one mile from shore.



STRUCTURAL STEEL is erected by The Austin Co., contractor of Cleveland, Ohio, to form new assembly plant for Boeing Aircraft Co. at Seattle, Wash. Plant building, 204 x 304 ft., involving 600 tons of steel, will have clear height of 35 ft. and will be entirely free of partitions and interior columns.

Quick Action Completes TRIBOROUGH BRIDGE PAVING *in Four Months*

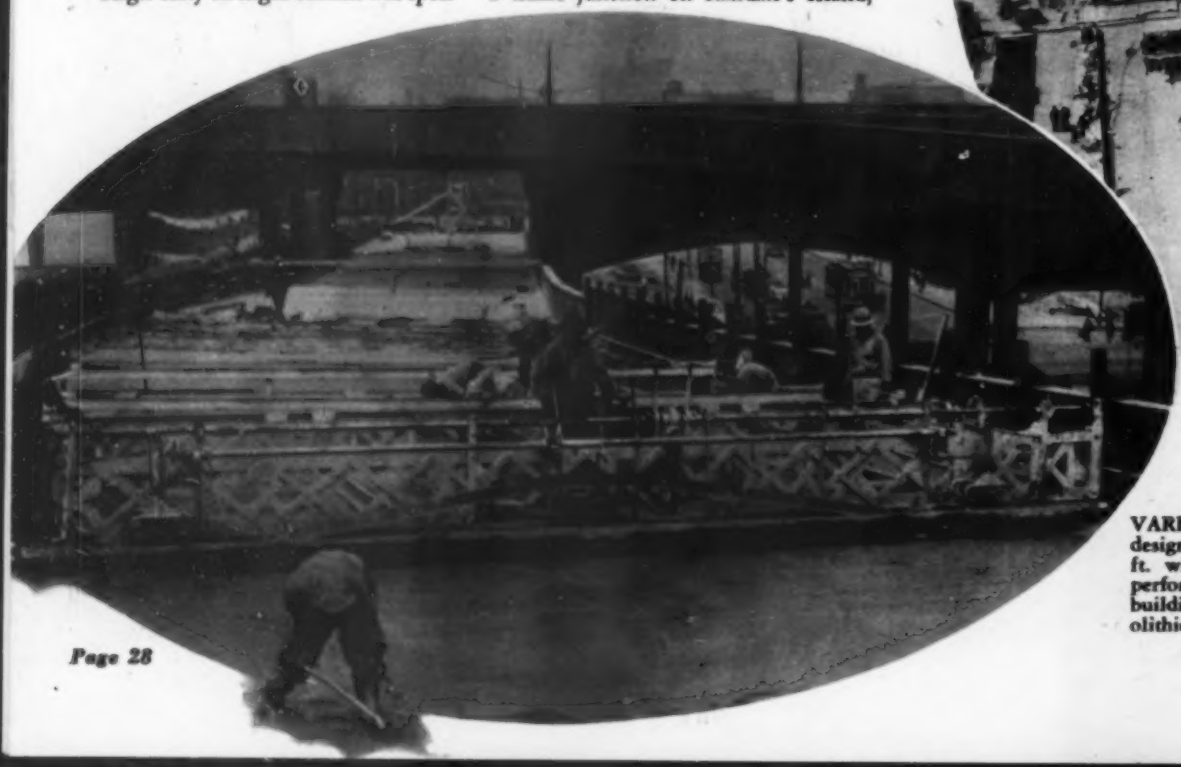
PECIAL FINISHING IACHINE traveling n elevated rails sus-ended from guard arriers, with screed perating under rails, nishes variable-width oncrete roadway 33½ 38½ ft. wide and multaneously builds onolithic lip curbs long both edges on anhattan appr umps leading to ft span crossin lem River

TWO FOUR-LANE ROADWAYS *(below)* **separated by central box - girder barrier carry vehicular traffic across typical deck girder spans connecting with west end of suspension bridge on Ward's Island anchorage.**

CONSTRUCTION SPEED backed up by reliable equipment, some of it of special design, completed more than 132,000 sq.yd. of roadway paving and 21,000 sq.yd. of sidewalk paving on the Triborough Bridge, New York City, in the four months preceding the official opening on July 11, 1936. Of the five contractors engaged in building the six paving sections, four used special finishing machines designed to operate on lanes of various widths and to strike off integral curbs monolithically with the marginal lanes. Concrete pumps, mast-hoists, tubular elevator towers, or long-boom cranes raised concrete to the bridge deck from central mixing plants or truck mixers on the ground. On the deck, dump trucks with special bodies delivered the concrete to the point of placement.

High-early-strength cement was specified to expedite construction and stripping of slab forms, which were made in demountable wood panels for repeated use. The panel forms were supported by collapsible frames of wooden joists resting on the lower flanges of I-section beams in the steel floor system. Portable gasoline-driven vibrators were used to consolidate the concrete and assure firm bond between the concrete and the mass of slab reinforcement, consisting of longitudinal bar trusses on 6½-in. centers and transverse rods spaced 9 in. apart in each of two horizontal layers. Bars in the two layers are staggered.

Triborough Bridge—Linking three boroughs of Manhattan, Bronx and Queens, the Triborough Bridge project, costing $42,000,000, consists in reality of three bridges converging in a traffic junction on Randall's Island,



VARIABLE - WIDTH FINISHER *(left)* **designed to surface roadway 33½ to 38½ ft. wide travels on rails suspended by perforated adjustable angle brackets in building superelevated curves with monolithic lip curbs on Manhattan ramps.**

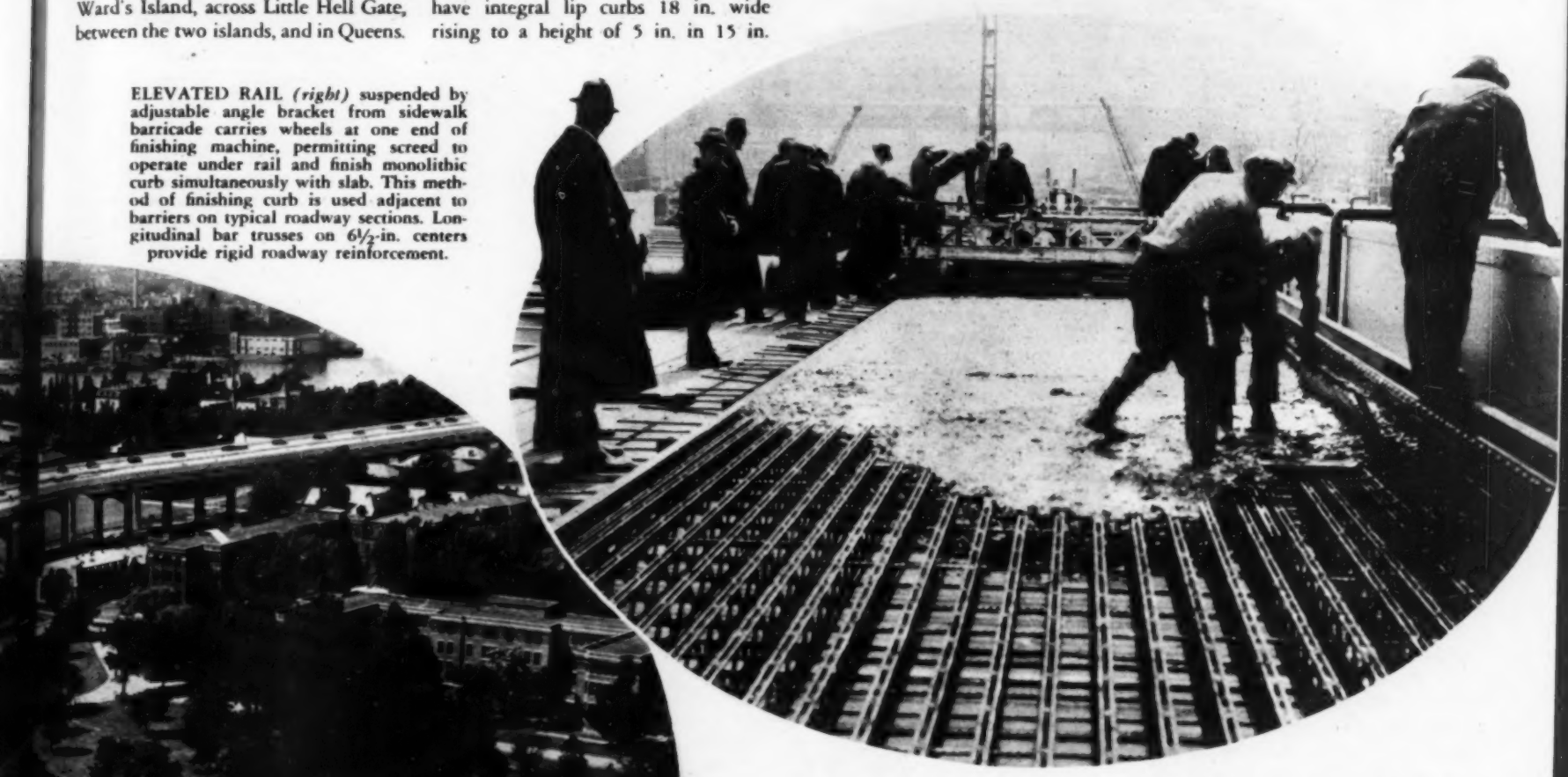
where an elevated three-level reinforced-concrete structure sorts and separates traffic traveling on the three radiating roadways, as well as traffic entering or leaving the island. Booths for the collection of tolls are located at this intersection.

A 1,380-ft. suspension span with 672-ft. side spans carries the Queens connection over Hell Gate, East River, and a 310-ft. vertical lift span flanked by two truss spans carries the Manhattan roadway across the Harlem River. Three truss spans (one designed for later conversion to a lift span) carry the Bronx approach across the Bronx Kills. Elsewhere the structures consist mainly of steel deck girder spans on concrete bents on Randall's Island, Ward's Island, across Little Hell Gate, between the two islands, and in Queens. Reinforced-concrete approaches are used at the three entrances to the project.

Roadway—In the main, the roadway consists of two 43½-ft. pavements separated by a central box-girder barrier. Each roadway carries four lanes of traffic. Except on the suspension span, which has a 7-in. roadway slab over the entire deck between anchorages, the roadways on the remainder of the project are 8½ in. thick. Width of the lanes varies. The outside lane adjacent to the sidewalk barricade is 12 ft. wide; the inside lane next to the central barrier is 11½ ft. wide; and the two intermediate lanes of each roadway have 10-ft. widths. Outside and inside lanes of each roadway, next to the barricade and central girder, have integral lip curbs 18 in. wide rising to a height of 5 in. in 15 in. Specifications required that the curb be placed and finished simultaneously with the lane.

Manhattan Approach—Special problems attached to the placing and finishing of concrete slab on curved approach ramps in Manhattan. Roadways of variable width ranging from 33½ to 38½ ft. passing around curves of about 200-ft. radius with superelevations up to 18 in. had to be built in one operation. The problem was further complicated by the fact that these roadways included integral curbs, of the type already described, which had to be cast and finished monolithically with the slab by the same machine. Specifications required that the curb be placed and finished simultaneously with the lane to place deck concrete and integral curb on all other contract sections involving slab on steel floor system.

Finishing Machines—For the difficult work on the Manhattan approach ramps, built by the Corbetta Construction Co., of New York City, the finishing machine had a frame and screed adjustable to variable widths. The frames and screed were extended by hand-operated ratchet mechanisms and contracted automatically. To hold the wheels of the machine on the elevated rails when traveling around sharp curves, the wheels were made double-flanged, or grooved, riding on the upturned leg of an angle which served as the rail. The rail was hung from the top of the safety barrier by adjustable perforated angle brackets which permitted adjustments up to 24 in. to take care of superelevations. Crank-handle screws at the tops of the brackets, to be noted in accompany-



ELEVATED RAIL *(right)* **suspended by adjustable angle bracket from sidewalk barricade carries wheels at one end of finishing machine, permitting screed to operate under rail and finish monolithic curb simultaneously with slab. This method of finishing curb is used adjacent to barriers on typical roadway sections. Longitudinal bar trusses on 6½-in. centers provide rigid roadway reinforcement.**

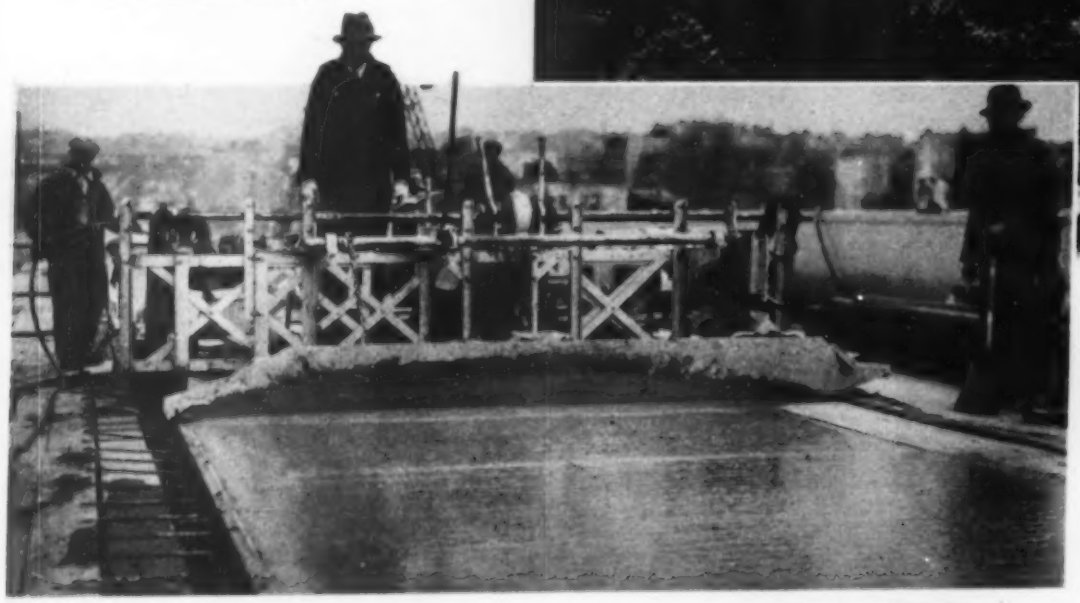
CURVED RAMPS *(right)* **of about 200-ft. radius superelevated to maximum of 18 in. complicate problem of finishing variable-width roadway with two integral curbs on Manhattan approaches.**

ing photographs, allowed final adjustments of the rail to grade.

On the finishing machine was mounted a single reciprocating screed designed to place and strike off the concrete for the integral curb to the proper profile. The screed operated under the supporting rails and did not ride on any forms.

At the Manhattan approach, the finishing machine traveled on suspended rails at both edges of the slab. Other machines used on the bridge, numbering five in all, were built to finish slabs 10 to 12 ft. wide, and the screeds were designed to place and finish concrete in one integral curb only. When building curb integrally with the extreme outside or inside lane, the end of the machine next to the barricade rode on an elevated rail suspended by brackets similar to those already described. This rail, however, had a standard road form tread, and the elevated wheels of the finishing machine also were of standard design. Rails were carried about 18 in. above the surface of the slab. At the other end of the finishing machine, the wheels traveled on the top flange of a steel form in the conventional manner. All the machines carried a single reciprocating screed arranged for forward and backward screeding.

STEEL HOIST TOWER, to be seen rising above far side of Ward's Island anchorage of suspension bridge, elevates concrete from mixing plant on ground to dump trucks on bridge deck. Same plant places concrete in final elements of anchorage.



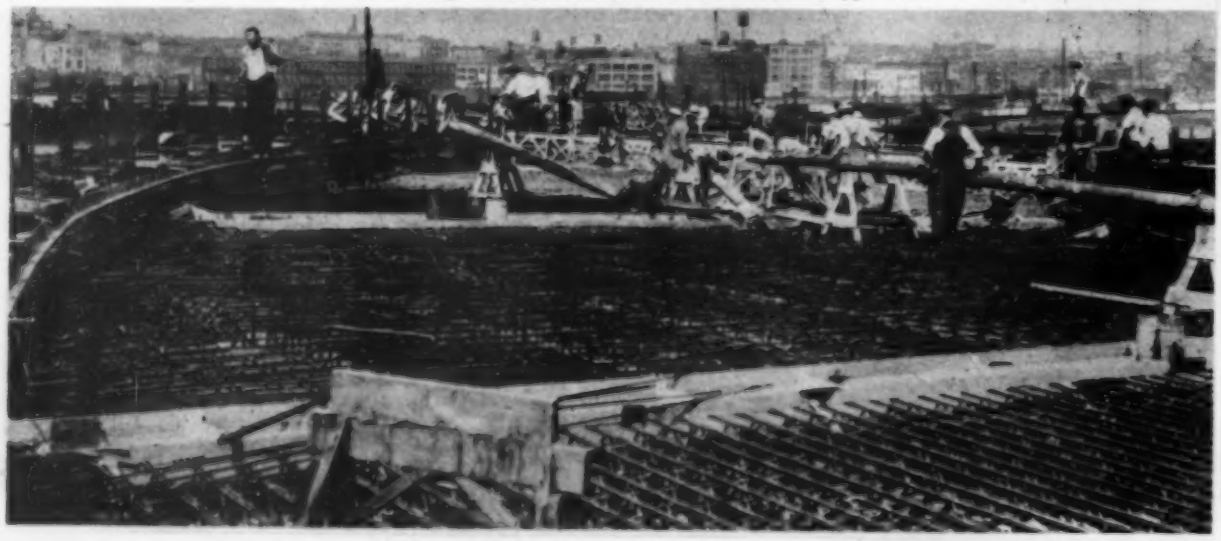
SLOPED SHOULDER *(left)* at one end of reciprocating screed finishes monolithic lip curb simultaneously with deck slab adjacent to safety barriers on typical roadway sections.

Roadway Edge Forms — All the contractors placing concrete deck slabs on the steel floor system utilized a special steel edge form designed by the Heltzel Steel Form and Iron Co. To accommodate the spacing of the transverse steel rods, which projected as dowels through the side forms, the forms were made to a special length of 10 ft. 6½ in. The forms had to be supported on transverse I-beams, or floor joists, of the deck system. These transverse beams were spaced at varying intervals of 4 to 6 ft. The form designers developed a supporting pedestal, adjustable both longitudinally and vertically, which could be moved along the form to engage a transverse beam at any point. Vertical and lateral adjustment in the pedestal permitted bringing the form to true grade and alignment. The top flange, or tread, of the form was 2½ in. wide, and the thickness of the steel was 3/16 to ¼ in. Where the supporting pedestal met this top tread, the pedestal was beveled to permit passage of the double-flanged finishing machine wheel.

Connections between abutting form

FLEXIBLE-SHAFT VIBRATORS, driven at 4,700 to 4,800 r.p.m. by gasoline motors, consolidate roadway concrete around bar trusses and transverse rods, assuring firm mortar bond to steel.

PUMPED CONCRETE *(below)* **is delivered by pipe line to point of placement on curved Manhattan approaches.**



STEEL ROAD FORMS of special design are supported by adjustable pedestals which can be moved longitudinally to engage steel floor joists spaced 4 to 6 ft. apart and adjusted vertically and transversely to obtain true grade and alignment. Transverse rods protruding through steel form will dowel completed slab to adjacent lane.

sections were made with special slide-lock form joints that overlapped abutting ends of the rails in the upper flange only to avoid fouling the steel dowel rods.

Paving Progress—On four of the paving contracts involving construction of concrete deck slab on steel floor system, the rate of progress was determined by the amount of slab which the finishing machine could complete in one day. On the fifth contract of this nature progress was limited by the capacity of equipment handling concrete from the ground to the point of placement in the deck. The sixth contract, involving the reinforced concrete structure and concrete slab in the traffic junction on Randall's Island, presented a somewhat different problem from the other sections.

Corbetta Construction Co.—On the Manhattan approaches the contract of

LONG-BOOM CRANE *(below)* lifts transit-mix concrete in 1-cu.yd. bucket from truck mixer on ground to hopper-body truck *(right)* on deck of Queens approach. All of outside lane adjacent to sidewalk and portion of second lane at lower end of approach were placed by crane directly from bucket, without use of hopper-body truck on deck.

TRUCK-MOUNTED HOPPER*(below)*, riding on completed slab of Queens approach, discharges concrete into adjacent lane, where it is consolidated by gasoline-engine-driven vibrators.

the Corbetta Construction Co called for the placing of 19,500 cu.yd. of structural concrete in addition to 22,000 sq.yd. of roadway paving and 3,300 sq.yd. of sidewalk. The roadway slab was reinforced with 230,000 lin.ft. of bar trusses, and the structural concrete with 3,100,000 lb. of steel rod. Structural work was started by the contractor on November 6, 1935.

Concrete on this section was conveyed to the point of placement by a Pumpcrete system. When paving the deck, the finishing machine completed as much as 530 lin. ft. of 33½ to 38½ ft. variable width slabs with two integral curbs in one day.

Tully & Di Napoli, Inc.—Two contracts were executed by Tully & Di Napoli, Inc. On each of these decks, roadway slabs were finished with a special finishing machine.

One contract involved the deck paving on the long steel viaduct leading from the traffic junction on Randall's Island to the main suspension span crossing the Hell Gate. This contract called for 51,000 sq.yd. of roadway slab and 7,000 sq.yd. of sidewalk. The concrete was reinforced with 955,000 lin. ft. of bar trusses and 920,000 lb. of steel rod. Work on this section started March 2, 1936.

Under its second contract this organization paved the Bronx approaches, placing 12,106 sq.yd. of roadway slab and 3,300 sq.yd. of sidewalk, in addition to 6,108 cu.yd of structural concrete. Roadway reinforcement required 227,000 lin. ft. of bar trusses, and the entire contract required 1,167,000 lb. of steel reinforcing rods. Operations on this section began March 6, 1936.

Tully & Di Napoli mixed concrete in central plants on the ground and elevated it to the bridge deck with mast-hoist units. Dump trucks with special bathtub bodies hauled the concrete from the mast-hoist to the point of placement. Temporary plank roadways were laid for the trucks to distribute concrete to the first lane placed. Using a truck distributing system, this contractor was able to finish as much as 1,700 lin. ft. of 10-ft. lane, or 1,200 to 1,300 lin. ft. of 12-ft. lane with integral curb, in a single day.

Albert A. Volk Co.—On the main suspension span the Albert A. Volk Co. had a contract calling for 29,600 sq.yd. of roadway slab and 5,000 sq.yd. of sidewalk, in addition to 25,800 cu.yd. of structural concrete required to finish the anchorages and build concrete stairways connecting low-level sidewalk on the approach viaduct with high-level sidewalk on the suspension bridge. Roadway reinforcement involved 557,000 lin. ft. of bar trusses, and the total requirement for reinforcing rods amounted to 1,230,000 lb. Construction operation on this contract started February 24, 1936. A small amount of work on the anchorages continued after July 11, but all the paving was completed prior to that date.

Concrete was mixed in a central plant on the ground at the Ward's Island end of the section and was elevated to the bridge deck by a tubular steel hoist tower. This contractor also employed a temporary plank runway and dump trucks for initial distribution of concrete.

Specifications required that the contractor keep a balanced load on the suspension span when placing concrete for the outside and inside lanes of each roadway. This requirement called for frequent moves or equipment from one point of concreting to another. Two finishing machines utilized on this section were provided with transportation carriages to facilitate movement from place to place on the bridge. In spite of delays caused by moving the equipment in order to maintain the balanced load, the contractor completed about 800 lin. ft. per day in the first two lanes on each roadway.

After the outside and inside lanes

COLORLESS CURING COMPOUND sprayed on top surface of slab sets quickly to form thin elastic layer capable of resisting rain, hail and changes of temperature.

of each roadway had been completed, the contractor was permitted to concrete the two intermediate lanes in a continuous operation from one end of the bridge to the other. On these four final lanes, the finishing machines were able to complete 1,600 to 1,700 lin. ft. per day.

Poirier & McLane Corp.—Structural concrete and deck slabs at the Randall's Island junction called for a total of 72,000 cu.yd. of concrete. The concrete was reinforced with 11,500,000 lb. of reinforcing rod. In addition, the contract called for 48,000 lin. ft. of bar trusses for a small amount of deck paving in the bridge section. The contractor began operation about November 6, 1935. Concrete in columns was placed by buckets and deck concrete by a Pumpcrete installation.

P. T. Cox Contracting Co.—On the Queens approach to the main suspension span the P. T. Cox Contracting Co. built a section involving 17,600 sq.yd. of roadway slab and 2,060 sq. yd. of sidewalk, in addition to 6,900 cu.yd. of structural concrete in a short section of concrete ramp at the lower end of the deck girder bridge. Roadway slab was reinforced with 287,200 lin. ft. of bar trusses, and the entire contract called for 1,560,000 lb. of reinforcing rod.

All of the concrete in the roadways and sidewalks on the steel spans was delivered by truck-mixers on the ground and raised to the bridge deck in 1-cu.yd. buckets by long-boom cranes. For this high lift, the job was equipped with a Speedcrane having on its regular boom a gooseneck jib extension which gave it a reach of 100 ft. and an Orton crane with a boom 90 ft. long. All of the outside lanes, next to the sidewalk barricade, and 600 ft. at the lower end of the second lane, were placed directly from a roller-gate bucket hung on the gooseneck jib of the crane with the 100-ft. reach. Beyond this point the contractor distributed concrete in a hopper truck which rode on a completed slab. All concrete was vibrated by a pair of Mall gasoline-driven internal vibrators operating at 4,700 to 4,800 r.p.m. Production was somewhat retarded by the methods of elevating the concrete to the bridge deck, but the finishing machines on this contract completed 800 to 900 lin. ft. of single-lane pavement per day.

Deck Forms—Under-slab forms used on this contract may be taken as representative of the type employed generally on the Triborough Bridge project. A single set of movable and demountable panel forms, sufficient for the paving of an entire lane 1,600 ft. long, was used eight times in placing the concrete on the eight lanes.

DUMP TRUCKS *(left)* **equipped with special bodies distribute concrete from tower hoists or mast hoists on three roadway paving sections. Contractors lay plank roadway for trucks hauling to first lane and use turntables to facilitate turning and dumping.**

DEMOUNTABLE PANEL FORMS resting on folding timber frames are moved ahead from lane to lane for eight successive uses.

WORKMEN *(left)* **drive wedges under bearing members of collapsible timber frame. Wedges are attached by wire to bearing members to prevent loss. Two of them may be seen hanging below nearest I-beam joist. Form panels have removable center piece to facilitate moving and erection.**

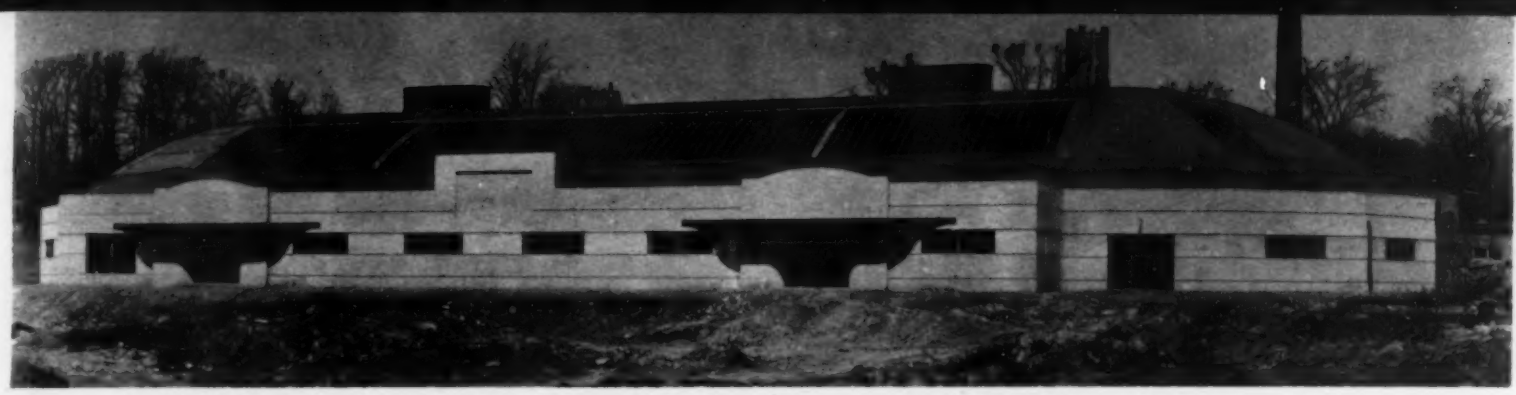
FORM PANELS *(left)* **have been moved from completed lane at left and erected for placement of adjacent lane. Note bearing members of supporting frames wedged up from lower flanges of I-beam joists. Bottom of completed slab has been sprayed with coating of bituminous curing compound.**

To fill the span between steel joints of the floor system, the contractor used panels 6 ft. long (a pair being sufficient to take care of a 12-ft. lane) supported by folding, or collapsible, framework of 2x4's and 2x8's which were wedged up from the lower flanges of the steel joists. The 2x4-in. wood joists of the form were cut to the desired profile of the jack arch between the steel joists. On the wood joists rested three panels of 1x6-in. roofing boards comprising the contact surface of the form, designed to facilitate moving and erection. Wedges, to prevent loss, were attached by wires to the 2x8-in. bearing strips of the folding frame. These details are indicated by accompanying photographs.

Curing Pavement—By spraying the bottom of the slab with Hunt process bituminous liquid sealing compound, the contractors were permitted to strip forms and move them ahead 36 hours after concrete was placed. The surface of the slab was protected during the curing period by a colorless coating of Ritecure, an elastic compound resembling a lacquer (made up of waxes, gums, resins and other substances in a petroleum solvent) applied in a thin layer with a pressure spray. This material was sprayed on the surface as soon as the concrete had taken its initial set. After 15 min. of normal curing weather, the Ritecure had set sufficiently to withstand a heavy rain. After 30 min. the coating material could withstand any attack of the elements without damage.

Administration — Construction of the project was carried out by the Triborough Bridge Authority, a public body created by the New York State Legislature and headed by Commissioner Robert Moses as chief executive officer. For the Authority, O. H. Ammann is chief engineer, Edward W. Stearns, assistant chief engineer, Col. H. W. Hudson, engineer of construction, Austin Dana, engineer of design, J. C. Evans, engineer of approaches, and E. W. Bowden assistant to the chief engineer. J. E. Tonnelier is assistant to the engineer of construction, and R. F. Wheadon, H. R. Seely and R. T. Robinson are resident engineers.

A loan and grant for the construction of the project were provided by PWA, for which Wharton Green acted as resident project engineer and Charles E. Trout as deputy resident project engineer.



WALLS of colored architectural concrete and an arched roof of 122-ft. span supported by steel beams give Swarthmore College a commodious and attractive field house at moderate cost.

Monolithic Walls of COLORED CONCRETE *Cast in Self-Supporting Forms*

COLORED architectural concrete cast in self-supporting form units 20 ft. high lends special interest to the monolithic walls of a new athletic field house constructed at Swarthmore, Pa., by the Hughes-Foulkrod Co., of Philadelphia, for the trustees of Swarthmore College. Red clay shale, slaked and pulverized to make a paste, was added to an ordinary mixture of portland cement, sand and crushed rock to give the concrete a tone corresponding roughly to that of buff limestone. Portable form panels 25 ft. long faced with plywood and buttressed by timber bents supported the fresh concrete in the monolithic walls during placing at a scheduled rate of 2-ft. vertical rise per hour. Plywood panels on the opposite side of the wall were tied to the self-supporting units. Crawler cranes picked up and moved the portable units from one set-up to the next in a series of four uses for each unit.

Field House—With a clear arch span of 122 ft. and a maximum longitudinal dimension of 326 ft., the main central portion of the field house provides sufficient area for a 1/7-mi. cinder track, in addition to basketball courts and other playing spaces. In plan, this main portion of the field house comprises a rectangular central area 200 ft. long extending at both ends into roughly semi-circular areas of 62 ft. radius. The roof is supported by steel purlins framed into steel arch ribs fabricated from wide-flange rolled shapes, with a maximum clearance of 40 ft. from the floor of the field house to the crown of the arch.

Along the two straight sides of the field house are a series of rooms about 25 ft. square inclosed by monolithic walls of reinforced concrete 11½ ft. high. Transverse walls separating the rooms along each side of the field house serve as abutments to take the thrust of the roof arches. Foundations for these walls were carried to rock at depths ranging from 4 to 26 ft. below the level of the filled ground on which the field house was erected. Radial arch ribs at the two ends of the field house were designed as curved beams framed at their upper ends into a heavy transverse steel arch and supported at their lower ends on a vertical concrete wall.

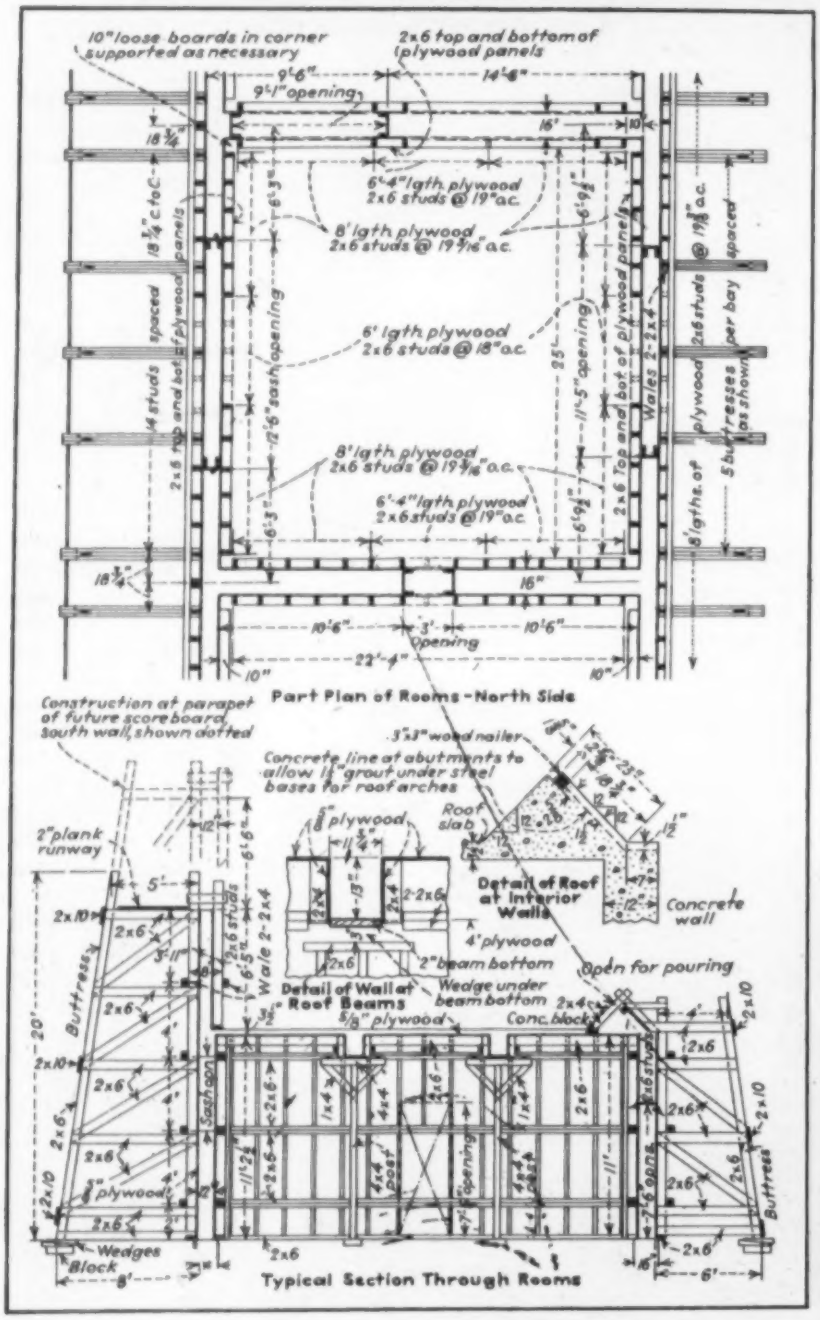
Quantities—Foundation walls of the field house required about 1,100 cu.yd. of concrete and about 50 tons of reinforcing steel, the latter being incorporated principally in wall beams 16 in. wide by 3 ft. deep which carry the interior and exterior walls of the series of rooms along the two sides of the field house. Superstructure work likewise required about 1,100 cu.yd. of concrete and 50 tons of reinforcing steel. Structural steel in the roof frame amounted to about 250 tons.

Wall Dimensions—Prior to the construction of the superstructure walls, abutment foundations were carried up from rock to grade, and wall beams to support the interior and exterior parallel walls were cast monolithically with these abutments. Superstructure walls then were built to 10½-ft. height in monolithic units 100 ft. long by 25 ft. wide. Abutment walls in general are 16 in. thick, both below and above grade, except where the foundation rock is more than 16 ft. below the surface of the ground. In the latter case, the abutment walls were made 24 in. thick from footing to roof. The footings under the abutment walls are 3 ft. wide.

Parallel interior and exterior walls along the two sides of the field house are 12 in. thick and 11½ ft. high above the concrete supporting beam. On top of the exterior wall is placed

INTERIOR of field house provides ample sports space inside ¼-mi. running track. Cross walls of rooms on two sides of main hall serve as buttresses to take thrust of roof arch ribs. Corrugated glass skylights give adequate daytime illumination.

SELF-SUPPORTING WALL FORM UNITS buttressed by timber frames and faced with plywood facilitate monolithic construction of walls for rooms on two sides of main play space. Central mixing plant equipped with boiler to heat materials is erected in this area at far end of field house.



PLAN AND SECTION of concrete forms for interior, exterior and cross walls indicate method of buttressing form units to permit monolithic construction of vertical structures 12 to 24 ft. high.

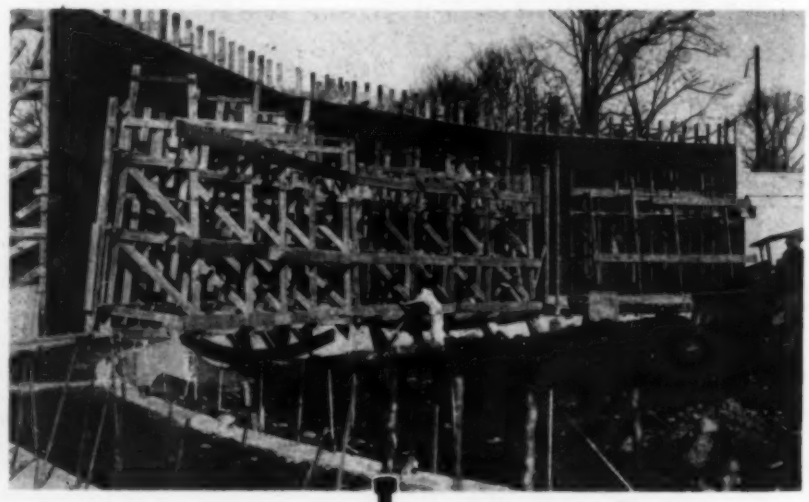
In the first concreting operation on the superstructure walls, concrete was placed monolithically to a level 10½ ft. above grade. For a unit 100 ft. long by 25 ft. wide, this operation required about 80 cu.yd. of concrete. In the second operation, roof beams, roof slab and parapet were cast monolithically.

Wall Form Units—Self-supporting wall form units 25 ft. long and 20 ft. high were constructed by the contractor in sufficient quantity to take care of the exterior wall on one entire side of the field house, 200 ft. in length. Similar self-supporting units about 14 ft. high carried the forms for the parallel interior wall along an entire side of the field house. The accompanying plan and section indicate the details of these framed timber units and of the plywood panel forms used in the construction of all the concrete walls.

After the self-supporting form units had completed the construction of the room walls on the two sides of the field house, they were used to form the curved walls at the ends of a building. To move a form unit from one set-up to the next, a crawler crane picked up and carried the unit on its load line by means of an 8x8-in. timber slipped under the top ledgers of the scaffold frame. When the unit had been set up for wall construction, these ledgers supported plank runways for workmen engaged in placing and spading concrete.

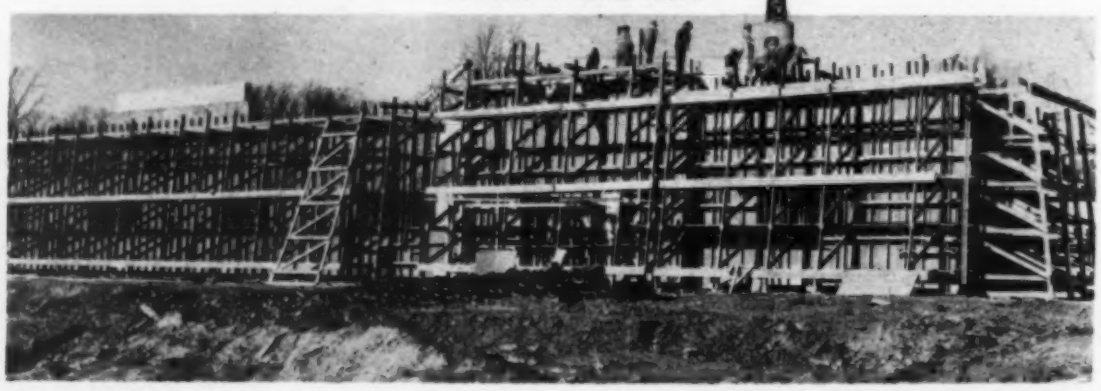
Internal vibration of wall concrete was given serious consideration in planning the construction of the field house but was rejected in favor of careful spading of the thin sections used. Careful spading gave satisfactory results. The exterior face of the outer walls was left untouched after the plywood forms were stripped.

Colored Concrete—A concrete mixture corresponding roughly to volumetric proportions of 1:2½:3½ was



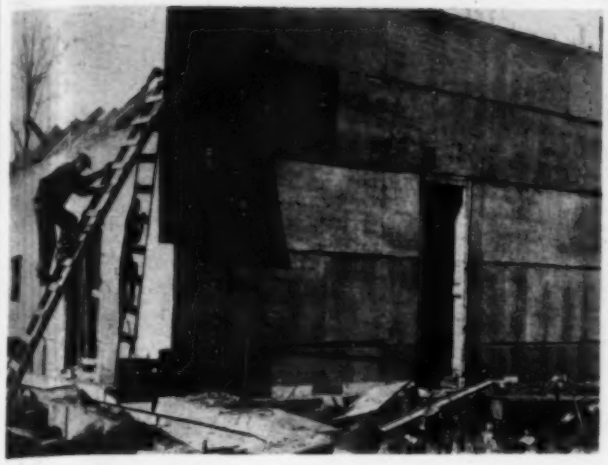
COLORED CONCRETE *(below)* produced by 27-S mixer is handled into wall forms by 1-yd. roller-gate bucket on boom of crawler crane.

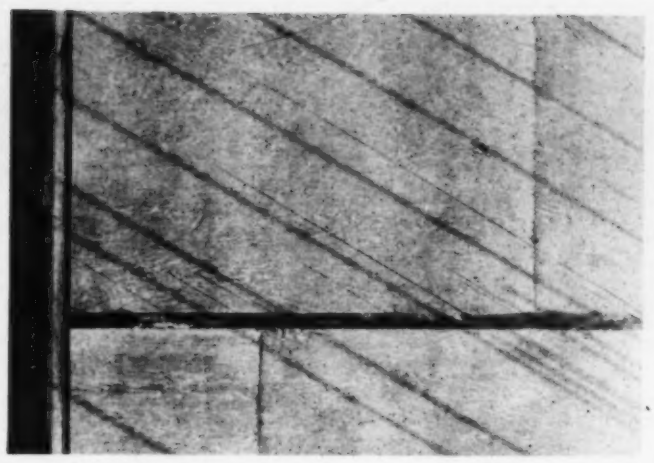
BUTTRESSED FORM UNITS are used also to construct exterior wall and parapet around curved end of field house.

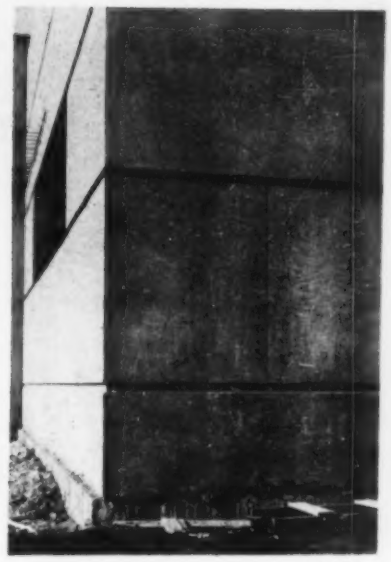


a parapet 8 in. thick and 6 ft. 5 in. high. In the center of the parapet on the south side of the field house is located a special panel 13 ft. high (extending 6½ ft. above the normal parapet level) with a recess in its outer face for a future scoreboard. This feature is indicated by one of the photographs and by a dash-line extension of the form in the sectional drawing.

To relieve the monotony of the exterior concrete face of the building, the surface is broken by horizontal grooves at 4-ft. intervals. These grooves were formed by attaching mitred battens 2-in. wide by 1-in. deep to the form surfaces at the horizontal joints between the plywood panels.







PLYWOOD PANELS *(left)* stripped from cross wall at one end of field house leave mitred battens in place *(center)* separating concrete into broad horizontal bands. Note texture of colored concrete cast against plywood form. With battens removed from grooves *(right)* concrete is revealed in final form, giving satisfactory surface without further finishing.

designed to produce a minimum compressive strength of 2,000 lb. per square inch at 28 days. Ordinary portland cement, sand and crushed limestone were used in the mixture, with 1-in. maximum size stone in the foundation concrete and ¾-in. stone in the superstructure concrete. Aggregates were measured in volumetric batchers, the sand being inundated in a special batching unit to eliminate changes in volume caused by unequal percentages of moisture. A 27-S mixer produced the concrete, which was handled into the wall forms in a 1-yd. roller-gate bucket by a crawler crane.

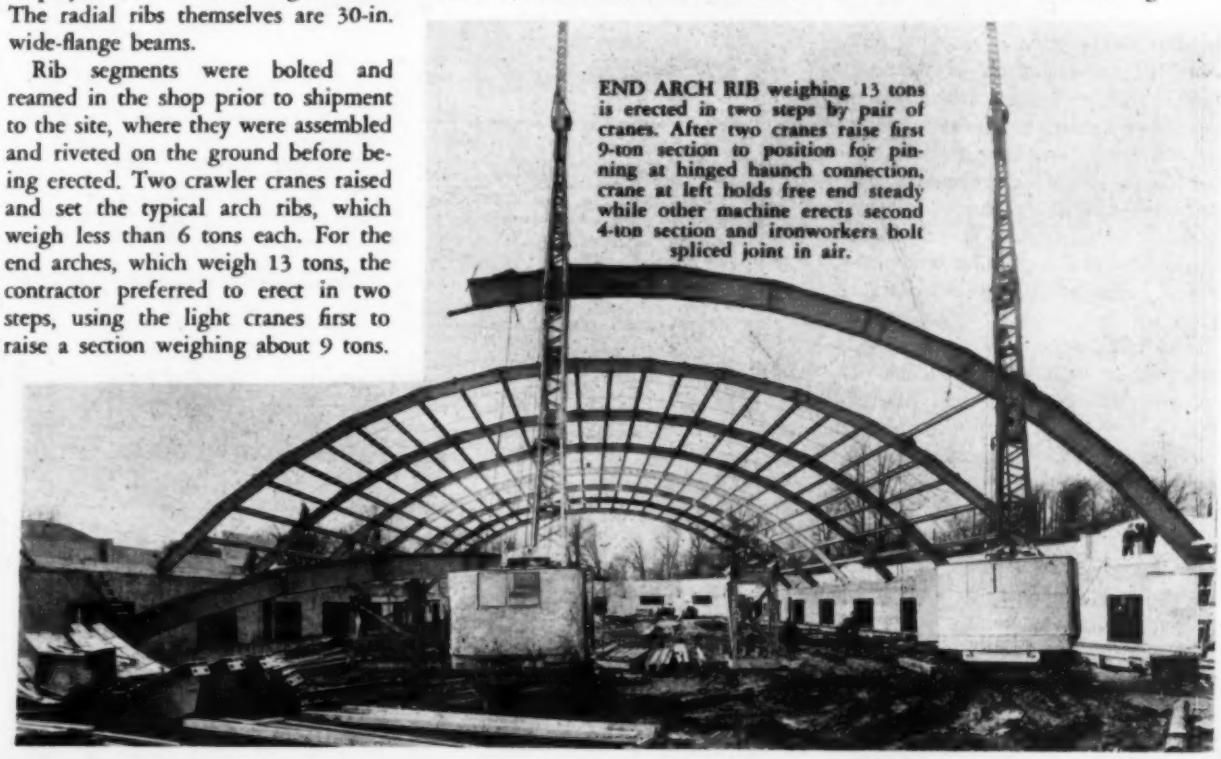
Color in the concrete was produced by adding to the mixture in the mixer drum a thick paste consisting of pulverized red clay and water. Red clay shale was shipped by truck to the job from Maryland and was slaked and pulverized by hand to form the paste. This mixture was added to the concrete in the proportion of 7½ lb. of paste to each sack of cement, 38 lb. being added to each cubic yard. In spite of the relatively high percentage of inert coloring matter added to the mixture, the strength tests of concrete samples taken at the job gave uniformly satisfactory results. The coloring matter produced a pleasing buff or soft salmon tone in the cured concrete.

Roof — Structural framing of the roof, designed by the Arch Roof Construction Co., of New York City, owner of the patent for this type of frame, utilized 21-in. wide-flange beams in the typical arches, spanning a clear distance of 122 ft. between side walls. For the two end arches, into which radial arch ribs are framed, the design employed 33-in. wide-flange beams. The radial ribs themselves are 30-in. wide-flange beams.

Rib segments were bolted and reamed in the shop prior to shipment to the site, where they were assembled and riveted on the ground before being erected. Two crawler cranes raised and set the typical arch ribs, which weigh less than 6 tons each. For the end arches, which weigh 13 tons, the contractor preferred to erect in two steps, using the light cranes first to raise a section weighing about 9 tons. After this section had been pinned at the haunch, one crane was able to support the load at the free end. The second crane then raised the remaining section of the arch rib to position for pinning at the abutment, and the final connection between the two sections was made by steel workers in the air.

Radial ribs were raised intact and, after being set on anchor bolts at the haunches, were connected to the crown of the end arch. Because of tight fit at the crown, this procedure could not be used for the final arch rib, which had to be raised in two sections and connected in the air.

Daylight is admitted into the interior of the field house through 7,500 sq.ft. of corrugated wire glass skylights in the roof. The remainder of the roof is covered with 17-in.-selvage red mineral roofing laid on two plies of tarred felt on wood decking.



END ARCH RIB weighing 13 tons is erected in two steps by pair of cranes. After two cranes raise first 9-ton section to position for pinning at hinged haunch connection, crane at left holds free end steady while other machine erects second 4-ton section and ironworkers bolt spliced joint in air.

RADIAL RIBS *(below)* framing into end arch are assembled on floor and raised intact with exception of sixth and final rib, which has to be erected in two sections because of tight fit at crown.

Progress and Cost — Concrete was placed in the first foundation footing on Oct. 15, 1935. Continuing operations through the coldest and most unfavorable winter on record, the contractor had the field house ready for opening on Feb. 15, 1936. Total cost of the building was $150,000.

Designers and Builders — Robert E. Lamb, of Philadelphia, a member of the board of trustees of Swarthmore College, prepared the original design for the field house, submitting his plans to Karcher & Smith, of Philadelphia, the architects, for architectural revisions and suggestions. The construction contract was executed by the Hughes-Foulkrod Co., of Philadelphia, under the direction of W. R. Hughes, Jr., president

INDEXES OF HIGHWAY CONSTRUCTION COSTS

Reported by the Division of Management, U. S. Bureau of Public Roads

THE PURCHASING POWER of funds expended for highway construction, when expressed in miles of highway annually placed under construction, shows variations from year to year because of (1) actual variations in the cost of materials and labor entering into such construction, and (2) changes in design features, types, and quantities of materials actually used.

The effect of lowered prices of constituent units is immediately reflected in a downward trend in costs per mile whenever the quantities of materials used and labor required are subject to only minor variations. However, changing traffic conditions have required wider surfaces, longer sight distances, flatter curves, and other features conducive to safety with increased speed. Consequently, the effects of lower unit prices during recent years have been largely offset by the increased quantities of materials and excavation actually used, and average costs per mile have not fluctuated in accordance with fluctuations in the unit price of materials.

As a normal consequence of constantly increasing traffic on our highways, highway construction is continually undergoing changes both in design and in materials used, and these changes have tended to complicate the development of simple index figures. To meet this condition three sets of index figures have been prepared.

1. A price trend index based on the varying unit costs of a composite mile composed of the same quantities and materials for each year.

2. A usage trend index that shows the variations in quantities of excavation, surfacing, and structures actually placed in the composite mile constructed each year.

3. A cost trend index that is based on the actual cost of the composite mile constructed each year.

Data for the federal fiscal years 1925 to 1929 were taken as a basis for the calculations. The variations in price trend for the years 1922 to 1935 for the major components as well as for the composite mile are shown in Fig. 1.

Price, cost, and usage trend indexes are shown in Fig. 2 for the period 1923 to 1934. The effects of price and usage are combined to produce a cost trend for the composite mile. The cost trend follows a more uniform course than does either the usage or the price trend.

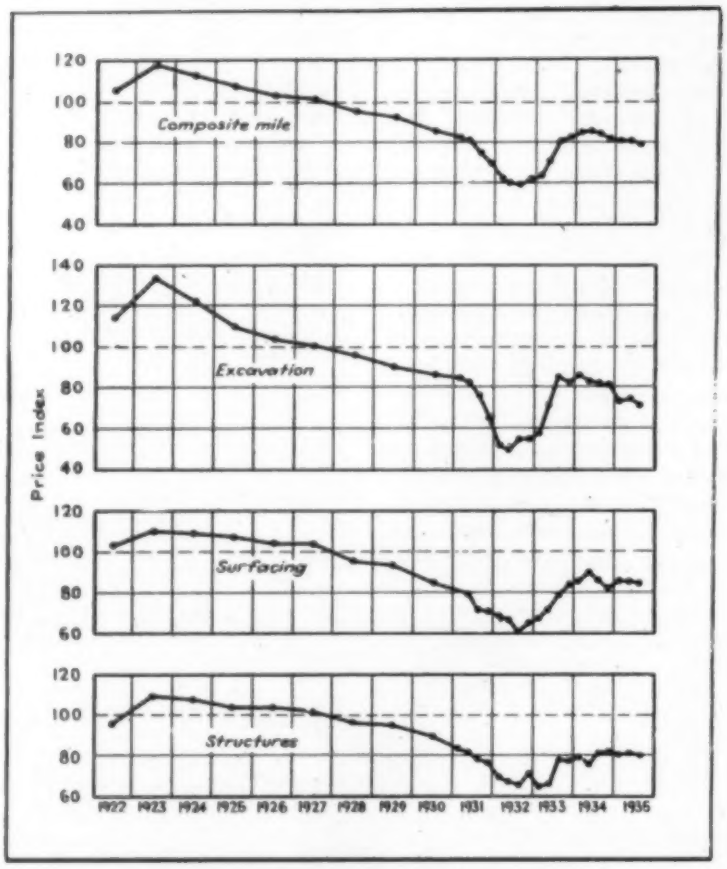


Fig. 1... PRICE TREND IN HIGHWAY CONSTRUCTION. Averages for 1925 to 1929 taken as a base.

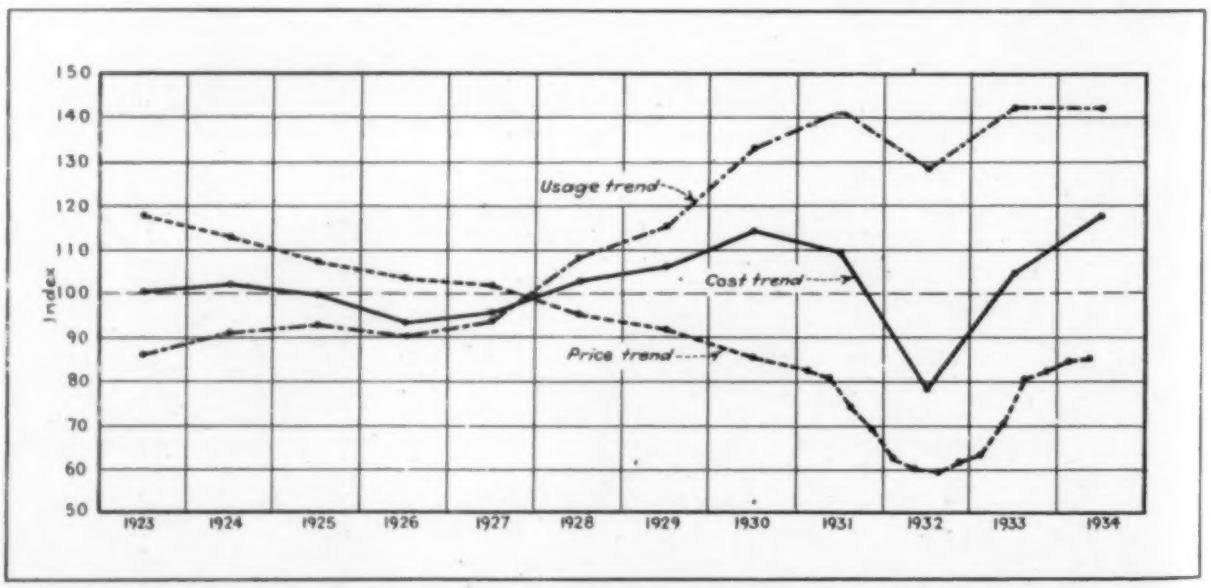


Fig. 2... INDEXES OF HIGHWAY CONSTRUCTION COST. Averages for 1925 to 1929 taken as a base. Price index shows trend in cost of composite mile composed of same quantities of excavation, surfacing, and structures in each year. Usage index shows trend in quantities of excavation, surfacing, and structures used per mile in each year. Cost index, taking account of usage, shows trend in actual cost per mile.

COST TREND FOR COMPOSITE MILE OF HIGHWAY

The data covering materials, quantities, and unit costs were collected by the Bureau of Public Roads from the prices shown in the contracts awarded for road construction financed in whole or in part from federal funds allotted to the states for construction on the federal-aid highway system. Samples were taken from work financed wholly with state funds and it was found that federal-aid and state projects were built to about the same standard.

Careful consideration of the available data led to the conclusion that a satisfactory usage index could be obtained if a composite mile of surfacing representative of the types of construction in federal-aid and state annual programs were used. Accordingly, the component types of surfacing entering into the composite mile were taken from records of the combined highway mileages built annually, and the correlated items (grading, structural concrete, and steel) were based on the records available from construction

Year	Excavation				Surfacing					Structures		
	Excavation	Gravel [1]	Water-bound macadam [2]	Total excavation	Bituminous macadam	Bituminous concrete [3]	Brick [4]	Portland-cement concrete	Total surfacing	Reinforcing steel	Structural steel	Structural concrete
	Cubic yards	*Cubic yards*	*Cubic yards*	*Cubic yards*	*Square yards*	*Square yards*	*Square yards*	*Square yards*	*Square yards*	*Pounds*	*Pounds*	*Cubic yards*
1923	8,068	3,846	1,002	12,916	453	307	227	2,764	3,751	9,270	2,297	53
1924	8,364	3,792	1,237	13,393	391	351	137	2,960	3,839	12,374	2,258	67
1925	9,238	4,116	945	14,299	385	284	120	2,978	3,767	13,581	4,718	64
1926	11,068	4,695	837	16,600	405	215	103	2,452	3,175	14,070	3,629	68
1927	10,960	4,310	1,329	16,599	400	237	53	2,850	3,540	12,773	3,301	64
1928	12,545	4,050	757	17,352	692	273	86	3,297	4,348	17,075	4,953	65
1929	17,028	4,548	1,029	22,605	350	213	62	3,173	3,798	22,503	5,024	81
1930	18,946	4,426	797	24,169	345	247	92	3,640	4,324	26,852	7,750	122
1931	22,361	4,801	683	27,845	423	214	75	3,283	3,995	30,751	12,216	141
1932	18,423	4,874	692	23,989	429	218	76	3,332	4,055	29,243	10,807	102
1933	21,461	5,017	908	27,386	561	492	81	2,609	3,743	32,131	19,249	153
1934	28,270	6,163	684	35,117	515	508	42	1,360	2,425	29,963	21,733	158

[1] Includes sand-clay and topsoil. [2] Includes treated and untreated macadam. [3] Includes sheet asphalt. [4] Includes all block pavements.

Table 1 . . . FINAL QUANTITIES per surfaced mile.

with federal funds. The propriety of the above procedure is assured by the fact that governing specifications are the same for both federal-aid and wholly state construction, and that design and supervision of construction are performed by the State highway departments.

In building highways throughout the country the engineer must take into account wide differences in soils, availability and quality of materials, temperature, rainfall, traffic and other factors, with a resulting wide range in

Year	Excavation		Surfacing		Reinforcing steel		Structural steel		Structural concrete	
	Quantity	Price per cubic yard	Quantity	Price per square yard	Quantity	Price per pound	Quantity	Price per pound	Quantity	Price per cubic yard
	Cu. yd.		*Sq. yd.*		*Lb.*		*Lb.*		*Cu. yd.*	
1925	14,299	$0.386	3,767	$2.360	13,581	$0.0565	4,718	$0.0567	64	$22.534
1926	16,600	.364	3,175	2.286	14,070	.0534	3,629	.0736	68	22.760
1927	16,599	.352	3,540	2.291	12,773	.0510	3,301	.0707	64	22.647
1928	17,352	.337	4,348	2.096	17,075	.0492	4,953	.0671	65	21.216
1929	22,605	.316	3,798	2.055	22,503	.0481	5,024	.0591	81	21.582
Total	87,455	1.755	18,628	11.088	80,002	.2582	21,625	.3372	342	110.739
Average	17,491	.351	3,726	2.218	16,000	.0516	4,325	.0674	68	22.148

Table 2 . . . AVERAGE QUANTITIES and prices for the years 1925 to 1929, used as a base for computation indexes.

Year	Excavation [1] (17,491 cubic yards)			Surfacing [2] (3,726 square yards)			Structures								Composite mile	
							Reinforcing steel (16,000 pounds)		Structural steel (4,325 pounds)		Structural concrete (68 cubic yards)		Combined			
	Bid price [3]	Amount	Sub-index	Bid price [3]	Amount	Sub-index	Bid price [3]	Amount	Bid price [3]	Amount	Bid price [3]	Amount	Amount	Sub-index	Total amount	Index
Base period, 1925 to 1929	$0.35	$6,139	100.0	$2.22	$8,264	100.0	$0.052	$826	$0.067	$291	$22.15	$1,506	$2,623	100.0	$17,026	100.0
1922	.40	7,031	114.5	2.28	8,488	102.7	.050	800	.074	321	20.18	1,372	2,493	95.1	18,012	105.8
1923	.47	8,186	133.3	2.43	9,047	109.5	.057	920	.078	338	23.37	1,589	2,847	108.6	20,060	117.9
1924	.43	7,504	122.2	2.40	8,950	108.3	.057	920	.077	333	22.91	1,558	2,811	107.2	19,265	113.1
1925	.39	6,751	110.0	2.36	8,793	106.4	.056	904	.067	288	22.53	1,532	2,724	103.9	18,268	107.3
1926	.36	6,367	103.7	2.29	8,518	103.1	.053	854	.074	318	22.76	1,548	2,720	103.7	17,605	103.4
1927	.35	6,157	100.3	2.29	8,536	103.3	.051	816	.071	306	22.65	1,540	2,662	101.5	17,353	101.9
1928	.34	5,894	96.0	2.10	7,810	94.5	.049	787	.067	290	21.22	1,443	2,520	96.1	16,224	95.3
1929	.32	5,527	90.0	2.05	7,657	92.7	.048	770	.059	256	21.58	1,468	2,494	95.0	15,678	92.1
1930	.30	5,300	86.3	1.86	6,949	84.1	.045	715	.061	264	20.08	1,365	2,344	89.4	14,593	85.7
1931																
First quarter	.30	5,195	84.6	1.79	6,666	80.7	.042	672	.055	240	18.90	1,285	2,197	83.7	14,058	82.6
Second quarter	.29	5,072	82.6	1.77	6,580	79.6	.041	658	.051	219	18.48	1,257	2,134	81.3	13,786	81.0
Third quarter	.27	4,705	76.6	1.59	5,924	71.7	.040	634	.052	224	17.49	1,189	2,047	78.0	12,676	74.4
Fourth quarter	.23	3,988	65.0	1.56	5,809	70.3	.037	594	.056	244	17.22	1,171	2,009	76.6	11,806	69.3
1932																
First quarter	.18	3,166	51.6	1.52	5,656	68.4	.036	571	.049	211	15.22	1,035	1,817	69.3	10,639	62.5
Second quarter	.17	2,991	48.7	1.47	5,481	66.3	.034	538	.045	197	14.98	1,019	1,754	66.8	10,226	60.1
Third quarter	.19	3,358	54.7	1.35	5,045	61.0	.033	526	.043	184	14.82	1,008	1,718	65.5	10,121	59.4
Fourth quarter	.19	3,323	54.1	1.44	5,377	65.1	.033	528	.048	208	16.28	1,107	1,843	70.3	10,543	61.9
1933																
First quarter	.20	3,498	57.0	1.49	5,552	67.2	.032	506	.043	187	15.44	1,050	1,743	66.4	10,793	63.4
Second quarter	.25	4,338	70.7	1.58	5,894	71.3	.035	552	.043	188	14.67	997	1,737	66.2	11,969	70.3
Third quarter	.30	5,194	84.6	1.74	6,498	78.6	.041	657	.049	212	17.36	1,180	2,049	78.1	13,741	80.7
Fourth quarter	.29	5,054	82.3	1.85	6,904	83.5	.042	669	.049	212	17.12	1,163	2,044	77.9	14,002	82.2
1934																
First quarter	.30	5,247	85.5	1.90	7,079	85.7	.042	672	.049	212	17.82	1,212	2,096	79.9	14,422	84.7
Second quarter	.29	5,072	82.6	1.98	7,377	89.3	.042	678	.051	221	17.31	1,177	2,076	79.1	14,525	85.3
Third quarter	.29	5,016	81.7	1.92	7,161	86.7	.042	680	.053	231	17.98	1,222	2,133	81.3	14,310	84.0
Fourth quarter	.29	4,988	81.3	1.82	6,781	82.1	.044	712	.057	246	17.81	1,211	2,168	82.7	13,937	81.9
1935																
First quarter	.25	4,460	72.7	1.90	7,091	85.8	.044	699	.051	219	17.62	1,198	2,116	80.7	13,667	80.3
Second quarter	.26	4,548	74.1	1.89	7,031	85.1	.044	712	.052	225	17.51	1,191	2,128	81.1	13,707	80.5
Third quarter	.25	4,355	70.9	1.88	7,009	84.8	.044	709	.052	224	17.22	1,171	2,104	80.2	13,468	79.1

[1] Common excavation plus other excavation items expressed as equivalent common excavation.
[2] Portland-cement concrete plus other surfacing items expressed as equivalent portland-cement concrete
[3] Indexes and totals were calculated with the bid prices carried to 1 more decimal place than that to which they are shown in this table.

Table 3 . . . PRICE TREND in highway construction.

construction practice. Many materials are important locally but are of little significance to the country as a whole. Therefore, in the interest of simplifying reduction of data the following general items were selected as a basis for the indexes.

From Bureau of Public Roads records of bid prices:

Excavation—
- Common.
- Unclassified.
- Rock.

Year	Excavation [1] ($0.351 per cubic yard)			Surfacing [2] ($2.218 per square yard)			Structures								Composite mile	
							Reinforcing steel ($0.0516 per pound)		Structural steel ($0.0674 per pound)		Structural concrete ($22.148 per cubic yard)		Combined			
	Quantity	Amount	Subindex	Quantity	Amount	Subindex	Quantity	Amount	Quantity	Amount	Quantity	Amount	Amount	Subindex	Total amount	Index
	Cubic yards			*Square yards*			*Pounds*		*Pounds*		*Cubic yards*					
Base period, 1925 to 1929...	17, 491	$6, 139	100. 0	3, 726	$8, 264	100. 0	16, 000	$826	4, 325	$291	68	$1, 506	$2, 623	100. 0	$17, 026	100. 0
1923	12, 916	4, 533	73. 8	3, 751	8, 320	100. 7	9, 270	478	2, 297	155	53	1, 174	1, 807	68. 9	14, 660	86. 1
1924	13, 393	4, 701	76. 6	3, 839	8, 515	103. 0	12, 374	638	2, 258	152	67	1, 484	2, 274	86. 7	15, 490	91. 0
1925	14, 299	5, 019	81. 7	3, 767	8, 355	101. 1	13, 581	701	4. 718	318	64	1, 417	2, 436	92. 9	15, 810	92. 9
1926	16, 600	5, 827	94. 9	3, 175	7, 042	85. 2	14, 070	726	3, 629	245	68	1, 506	2, 477	94. 4	15, 346	90. 1
1927	16, 599	5. 826	94. 9	3, 540	7, 852	95. 0	12, 773	659	3, 301	222	64	1, 417	2, 298	87. 6	15, 976	93. 8
1928	17, 352	6, 091	99. 2	4, 348	9, 644	116. 7	17, 075	881	4, 953	334	65	1, 440	2, 655	101. 2	18, 390	108. 0
1929	22, 605	7, 934	129. 2	3, 798	8, 424	101. 9	22, 503	1, 161	5, 024	339	81	1, 794	3, 294	125. 6	19, 652	115. 4
1930	24, 169	8, 483	138. 2	4, 324	9, 591	116. 0	26, 852	1, 386	7, 750	522	122	2, 702	4, 610	175. 7	22, 684	133. 2
1931	27, 845	9, 774	159. 2	3, 995	8, 861	107. 2	30, 751	1, 587	12, 216	823	141	3, 123	5, 533	210. 9	24, 168	141. 9
1932	23, 989	8, 420	137. 2	4, 055	8, 994	108. 8	29, 243	1, 509	10, 807	728	102	2. 259	4, 496	171. 4	21, 910	128. 7
1933	27, 386	9, 612	156. 6	3, 743	8, 302	100. 5	32, 131	1, 658	19, 249	1, 297	153	3, 389	6, 344	241. 9	24, 258	142. 5
1934	35, 117	12, 326	200. 8	2, 425	5, 379	65. 1	29, 963	1, 546	21, 733	1, 465	158	3, 499	6, 510	248. 2	24, 215	142. 2

[1] Common excavation plus other excavation items expressed as equivalent common excavation.
[2] Portland-cement concrete plus other surfacing items expressed as equivalent portland-cement concrete.

Table 4 . . . USAGE TREND in highway construction.

Year	Excavation [1]				Surfacing [2]				Structures										Composite mile	
									Reinforcing steel			Structural steel			Structural concrete			Combined		
	Bid price [3]	Quantity	Amount	Subindex	Bid price [3]	Quantity	Amount	Subindex	Bid price [3]	Quantity	Amount	Bid price [3]	Quantity	Amount	Bid price [3]	Quantity	Amount	Amount	Subindex	Amount	Index
		Cubic yards				*Square yards*				*Pounds*			*Pounds*			*Cubic yards*					
Base period, 1925 to 1929.	$0. 35	17, 491	$6, 139	100. 0	$2. 22	3, 726	$8, 264	100. 0	$0. 052	16, 000	$826	$0. 067	4, 325	$291	$22. 15	68	$1, 506	$2, 623	100. 0	$17, 026	100. 0
1923	. 47	12, 916	6, 045	98. 5	2. 43	3, 751	9, 107	110. 2	. 057	9, 270	533	. 078	2, 297	180	23. 37	53	1, 239	1, 952	74. 4	17, 104	100. 5
1924	. 43	13, 393	5, 746	93. 6	2. 40	3, 839	9, 221	111. 6	. 057	12, 374	711	. 077	2, 258	174	22. 91	67	1, 535	2, 420	92. 3	17, 387	102. 1
1925	. 39	14, 299	5, 519	89. 9	2. 36	3, 767	8, 890	107. 6	. 056	13, 581	767	. 067	4, 718	318	22. 53	64	1, 442	2, 524	96. 2	16, 933	99. 5
1926	. 36	16, 600	6, 042	98. 4	2. 29	3, 175	7, 268	87. 8	. 053	14, 070	751	. 074	3, 629	267	22. 76	68	1, 548	2, 566	97. 8	15, 866	93. 2
1927	. 35	16, 599	5, 843	95. 2	2. 29	3, 540	8, 110	98. 1	. 051	12, 773	651	. 071	3, 301	233	22. 65	64	1, 449	2, 333	89. 0	16, 286	95. 7
1928	. 34	17, 352	5, 848	95. 2	2. 10	4, 348	9, 113	110. 3	. 049	17, 075	840	. 057	4, 953	332	21. 22	65	1, 379	2, 551	97. 3	17, 512	102. 9
1929	. 32	22, 605	7, 143	116. 4	2. 05	3, 798	7, 805	94. 4	. 048	22, 503	1, 062	. 059	5, 024	297	21. 58	81	1, 748	3, 127	119. 2	18, 075	106. 2
1930	. 30	24, 169	7, 323	119. 3	1. 86	4, 324	8, 064	97. 6	. 045	26, 852	1, 209	. 061	7, 750	473	20. 08	122	2, 449	4, 122	157. 2	19, 509	114. 6
1931	. 27	27, 845	7, 546	122. 9	1. 68	3, 995	6, 696	81. 0	. 040	30, 751	1, 227	. 054	12, 216	655	18. 02	141	2, 541	4, 423	168. 6	18, 665	109. 6
1932	. 18	23, 989	4, 378	71. 3	1. 44	4, 055	5, 859	70. 9	. 034	29, 243	994	. 046	10, 807	499	15. 32	102	1, 563	3, 056	116. 5	13, 293	78. 1
1933	. 26	27, 386	7, 066	115. 1	1. 67	3, 743	6, 240	75. 5	. 037	32, 131	1, 193	. 046	19, 249	889	16. 15	153	2, 470	4, 554	173. 6	17, 860	104. 9
1934	. 29	35, 117	10, 184	165. 9	1. 91	2, 425	4, 622	55. 9	. 043	29, 963	1, 265	. 052	21, 733	1, 139	17. 73	158	2, 801	5, 225	199. 2	20, 031	117. 6

[1] Common excavation plus other excavation items expressed as equivalent common excavation.
[2] Portland-cement concrete plus other surfacing items expressed as equivalent portland-cement concrete.
[3] Indexes and totals were calculated with the bid prices carried to 1 more decimal place than that to which they are shown in this table.

Table 5 . . . COST TREND in highway construction.

Structures—
- Reinforcing steel.
- Structural steel.
- Structural concrete, class A.
- Structural concrete, class B.
- Structural concrete, class C.

From records of mileage of state highways constructed:
- Gravel and sand-clay.
- Macadam.
- Bituminous macadam.
- Bituminous concrete.
- Portland-cement concrete.
- Brick.

These items cover somewhat more than 90 per cent of the total cost of highway construction. Therefore, though their number is not great, they appear to be adequate. The items not used involve about the same basic commodities, manufacturing processes, transportation problems, and the same classes of labor that were involved in the items used. To include them would complicate the calculations but probably would neither clarify nor improve the result.

These representative items were accumulated and weighted, and further consolidated into three general groups — excavation, surfacing, and structures. The general group of excavation, includes the three types of excavation, common, rock, and unclassified, and in addition, includes the low-type surfaces such as topsoil, sand-clay, gravel, and treated and untreated macadam. These low-type surfaces have a low materials cost, generate little freight, and in construction methods and nature of equipment used are similar to grading operations, and so may be readily converted into the general group of excavation. In a similar manner the rigid types of surfacing have been converted into equivalent concrete pavement. Structures, which include bridges, culverts, railroad grade crossings, and safety devices, were reduced to three items: reinforcing steel, structural steel, and structural concrete. The resulting final quantities per surfaced mile are shown in Table 1.

Base quantities and base prices (1925 to 1929) are shown in Table 2. The base quantities and prices are the arithmetical averages of the quantities and prices by years for the base period.

The Price Index.—The method of computing the price index is shown in Table 3. The composite mile on which the price index is based is composed of the average quantities of excavation, surfacing, and structures as determined for the base period 1925 to 1929. The average bid price for each of these items is shown for the years 1922 to 1935. The figures given in the amount columns are the costs of the average quantities at the prevailing rate for the year or quarter. The index figures give a comparison between the year or quarter and the base period 1925 to 1929. The results given in this table are shown in graphical form in Fig. 1.

The Usage Index.—The usage index shows the effect of changing practices in design features and use of materials in the highway construction field. It is obtained by applying the average prices as determined for the base period to the various quantities of the base items used. The result shows how the cost would have varied because of changing usage had the unit prices remained constant. These changes in construction practices are shown in tabular form in Table 4, and graphically by the usage trend in Fig. 2.

The Cost Index.—The cost index is obtained by combining the average annual quantities used, as shown in Table 4, with the average annual unit prices that they cost. This index is shown in tabular form in Table 5 and graphically by the cost trend in Fig. 2.

"EARTHWORM DIESEL". Traveling under assumed name Caterpillar diesel tractor makes unusual starring vehicle for Joe E. Brown, aided by Guy Kibbe, in new photoplay, "Earthworm Tractors," released by Warner Bros. Pictures, Inc. and based on series of stories in Saturday Evening Post by William Hazlett Upson.

SOOTHING AS AN ELECTRIC FAN. Sir James Pervis Stewart, nerve specialist and member of London's anti-noise council, operates silent, self-contained, gasoline-powered Warsop drill during demonstration conducted under supervision of City of Westminster Works Committee Council in England.

Wide World Photo

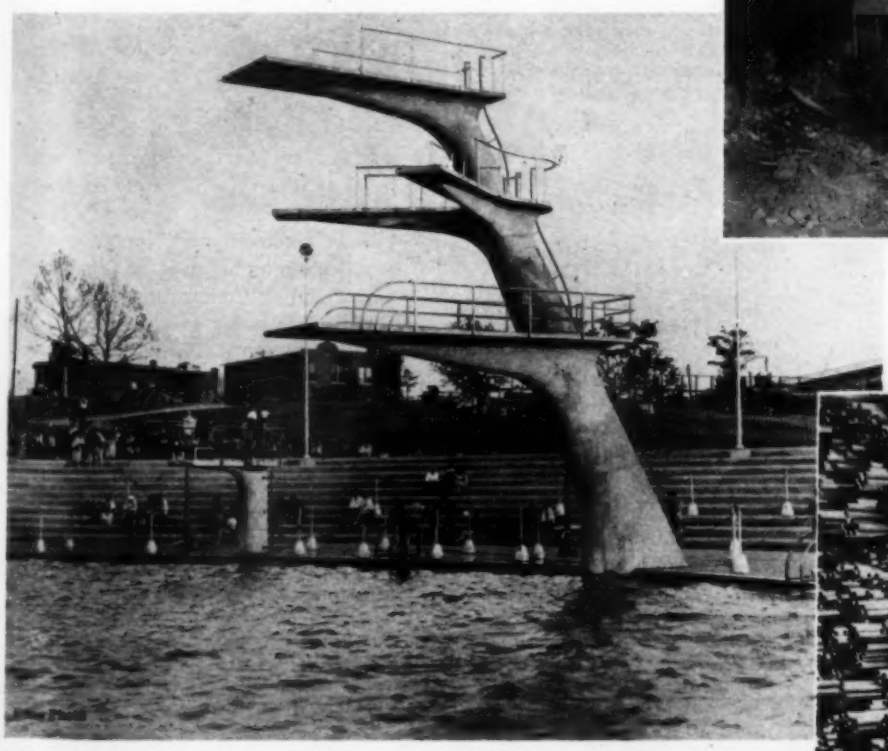
JOB ODDITIES

A MONTHLY PAGE OF

Unusual Features of Construction

CELLAR DIGGER owned by Crane Service Co., Washington, D. C., deepens basement 7 ft. under Hecht's Department store without disturbing clerks and customers on floors above. Lorain shovel loads trucks in 40x125-ft. basement area.

U. S. Bureau of Reclamation Photo



STREAMLINED DIVING TOWER at new Astoria pool, New York City, built by WPA forces under direction of Department of Parks, carries platforms at three levels from which contestants made their plunges in final U. S. Olympic trials for women.

CONCRETE COOLING *(right)* at Grand Coulee dam requires 2,300 mi. of steel pipe buried in massive structure as construction progresses to cool concrete with circulating water while curing, expediting process and producing in short time shrinkage which otherwise would take years to complete. Artificial cooling prevents cracking caused by changes in volume such as would occur during protracted natural cooling period. Mason-Walsh-Atkinson-Kier Co. is building dam for U.S. Bureau of Reclamation.

SILO STAVES

Pave Streambed in Peoria Park Improvement

By JACOB A. HARMAN, Consulting Engineer, Peoria, Ill.

PRIOR TO PAVING with articulated mat, stream channel is shaped to uniform cross-section.

ARTICULATED MAT is made up of precast concrete blocks threaded on wire-rope tie-cables.

LINING a stream bed with concrete silo staves, strung on cable segments to form an articulated mat, is a feature of Peoria's $500,000 WPA force-account Woodruff Parkway and Dry Run improvement project. The project will provide flood protection and needed neighborhood recreation area. It consists of straightening, bringing to uniform cross-section and lining 6,800 lin. ft. of Dry Run, installing sanitary and storm sewer connections, constructing two 20-ft. roadways along the stream, with center parkway strip, and landscaping.

Design of Channel—To keep excavation to a minimum it was decided to follow the existing grade and alignment of the streambed in constructing a channel of uniform cross-section. The cross-section is designed to insure self-cleaning velocities at low flow and to take care of 3 in. per hour maximum flood runoff. Bottom width is 9 ft. 2 in., rounded to a radius of 8.3 ft. Concrete lining extends up each bank at a slope of 1½:1 to a 4:1 earth slope topped by a 2:1 slope extending to natural ground. The gradient varies from 0.7 to 1.2 per cent and averages 0.85 per cent.

Segmental Lining — In studying methods of paving the channel the idea was conceived of employing concrete segments woven into an articulated mat much like revetment used with success along the Mississippi. Various methods of building the segments were considered. The plan finally adopted was to lease the local plant and machinery of the Michigan Silo Co. during the winter months and build segments with silo stave forms. These forms were modified to provide two ¾-in. parallel holes through the slabs (for stringing connecting cable) and rounded "book-shaped" edges that would lie tightly together and allow rotation of adjoining segments to fit the channel contour.

About 50,000 segments were manufactured, to a size of 12x30x2½ in., with holes located at the quarter points. A 1:2:4 mixture was used, and segments were made on a vibrator to insure concrete of maximum strength and density. The segments were not reinforced.

Articulated mat was formed by laying pieces of ⅜-in. wire cable transversely across the excavated channel and stringing the segments on the cable. Transverse joints were staggered. The entire mat required 60,000 ft. of cable. Segments were easily handled by two men. The block laying crew followed immediately behind a gang which dressed and tamped the soil to insure uniform bearing.

After a short period of experimentation and training, the crew of WPA workers developed a high degree of proficiency in dressing the channel and weaving blocks together. A smooth channel section with tight joints was obtained.

The project was begun in November, 1935, and is scheduled for completion July, 1937. It has provided work for 250 to 300 relief workers.

Acknowledgments—Woodruff Parkway and Dry Run improvement is sponsored by the City of Peoria of which E. N. Woodruff is mayor; William Conrad, commissioner of public works; and Charlotte S. Ashman, chairman, City Planning Commission. L. D. Jeffries is city engineer. The writer designed and is supervising the project, which is under the immediate direction of E. O. Pearson, resident engineer.

WPA work in this area is under James F. McElwee, director of District No. 6. C. W. Anderson is supervisor.

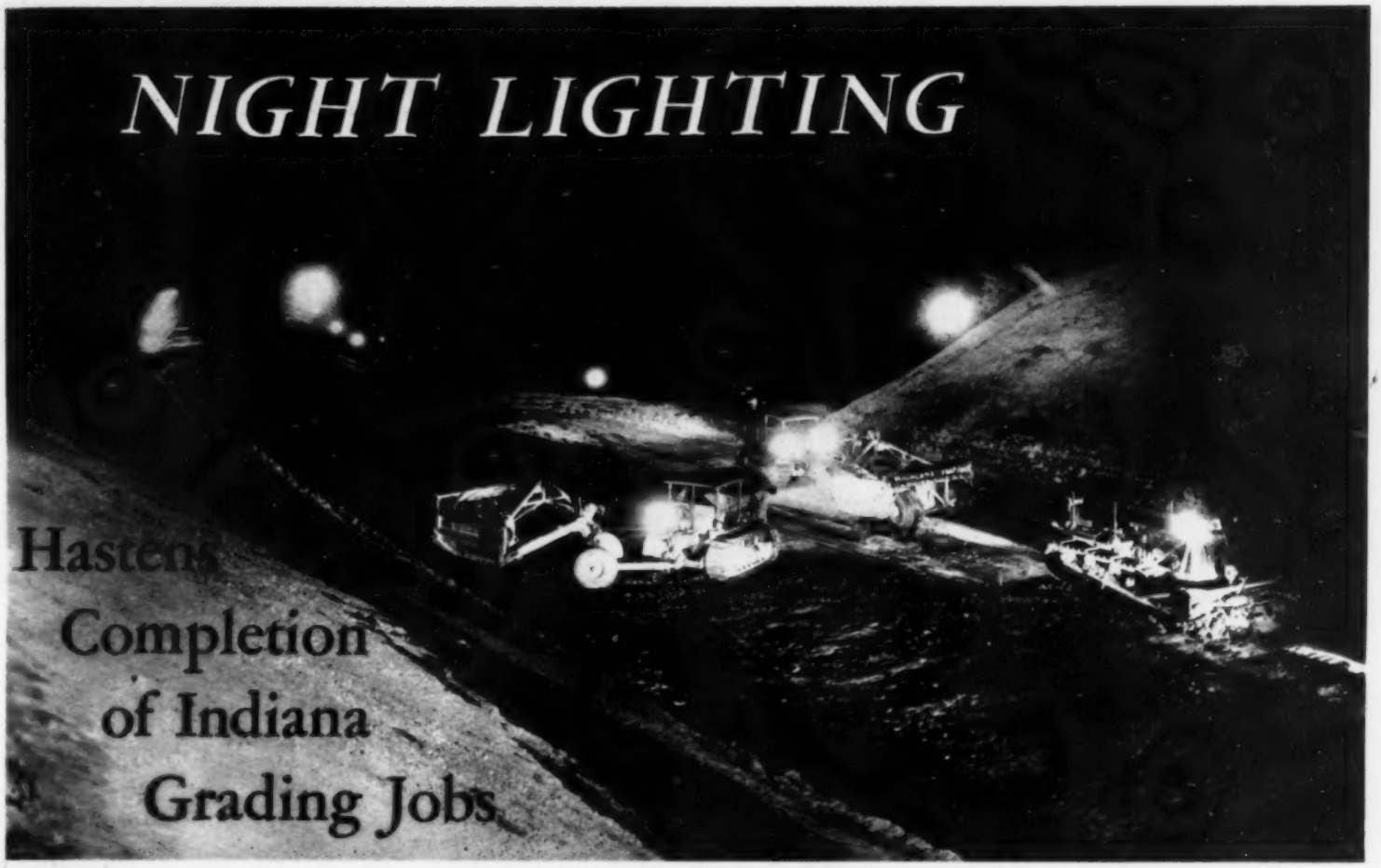
"BOOK-SHAPED" SLABS *(below)*, made with one long edge concave and other convex to allow some joint rotation, are strung on connecting cables passing through holes in slabs.

LARGE FORCE of WPA workers *(left)* develops proficiency in shaping cross-section and stringing precast blocks.

SEGMENTAL SLAB LINING *(right)* of completed channel utilizes precast blocks made during winter in silo stave plant.

NIGHT LIGHTING

Hastens Completion of Indiana Grading Jobs



ELECTRIC LIGHTS on tractors supplemented by 30 100-watt lamps strung along fill and in cut facilitate earth-moving operations at night on Indiana grading project.

USE OF LIGHTS for night work on highway grading projects is more general in Indiana this year than ever before. At least five contractors in the first part of the season used night illumination to speed construction of large grading jobs, working their men in two shifts and operating their equipment for 22 hr. out of every 24. The contract of the Highland Co., Inc., of Louisville, Ky., illustrated by the photographs, is representative of night work in the state.

This contract, awarded March 30, 1936, at a price of $158,935, involves the moving of 412,000 cu.yd. of earth in grading a 7½-mi. extension of Road 63, in Warren County, close to the Illinois state line. The Opossum Creek cut, ranging in depth to a maximum of 30 ft., calls for the heaviest grading on the project. Adjoining the cut is a fill running to a maximum depth of 30 ft. The cut contained about 50,000 cu.yd. of material.

Work in the cut started May 15, and the excavation was completed in 22 working days, with the equipment operating 22 hr. per day when weather permitted. Two 12-yd. LeTourneau scrapers drawn by Caterpillar 95-hp. RD 8 diesel tractors worked a total of 804 hr., an average of 402 hr. per scraper, and each scraper averaged about 62 yd. per hour. A 12-ft. tandem disk harrow was pulled behind one scraper, and both scrapers kept the fill level by dumping their loads in 9-in. layers for rolling by a Buffalo-Springfield 10-ton roller. The tractors and roller were equipped with lights, front and rear, and additional night lighting was furnished by a truck-mounted DK 5 generator which supplied current to 30 100-w. lamps fitted with reflectors. A bulldozer attachment on a third RD 8 made a road for the scrapers.

In all, the three 95-hp. diesel tractors worked a total of 918 hr. in moving the 50,000-yd. cut. These hours were distributed as follows: Scrapers, 804; bulldozer, 95; rooter, or ripper, 14½; grading, 4½. Material in the cut comprised a top layer of about 4 ft. of loam and clay overlying about 6 ft. of sand and gravel, followed by hard blue clay containing pockets of other clays or sand. A vein of water encountered at the lower limits of the gravel stratum kept the cut wet.

In addition to the equipment used in the cut, the Highland Co., Inc., has on the job a Bucyrus-Erie 1¾-yd. shovel, nine Liberty trucks, a second Buffalo-Springfield 10-ton roller and a 10-ft. Caterpillar grader. The contract completion date is Dec. 31, 1936.

Other contractors using night lighting on Indiana grading projects in June included the Kyle Kileman Co., of Salem, on Road 250; the Ralph Meyers Co., of Campbellsburg, on Road 30 (for proposed divided-lane paving with 44 ft. parkway between 22-ft. roadways); the Ralph Rogers Co., of Bloomington, on Road 46; and the Howard Stroh Co., of Garrett, on Road 9.

James D. Adams is chairman of the Indiana State Highway Commission, and M. R. Keefe is chief engineer. Work on the Highland Co. contract on Road 63 is directed by the Crawfordsville district office, W. D. Irick, district engineer, and J. E. Sheldon, assistant engineer in charge of construction. At the site, H. O. Martin is project engineer in charge of operations.

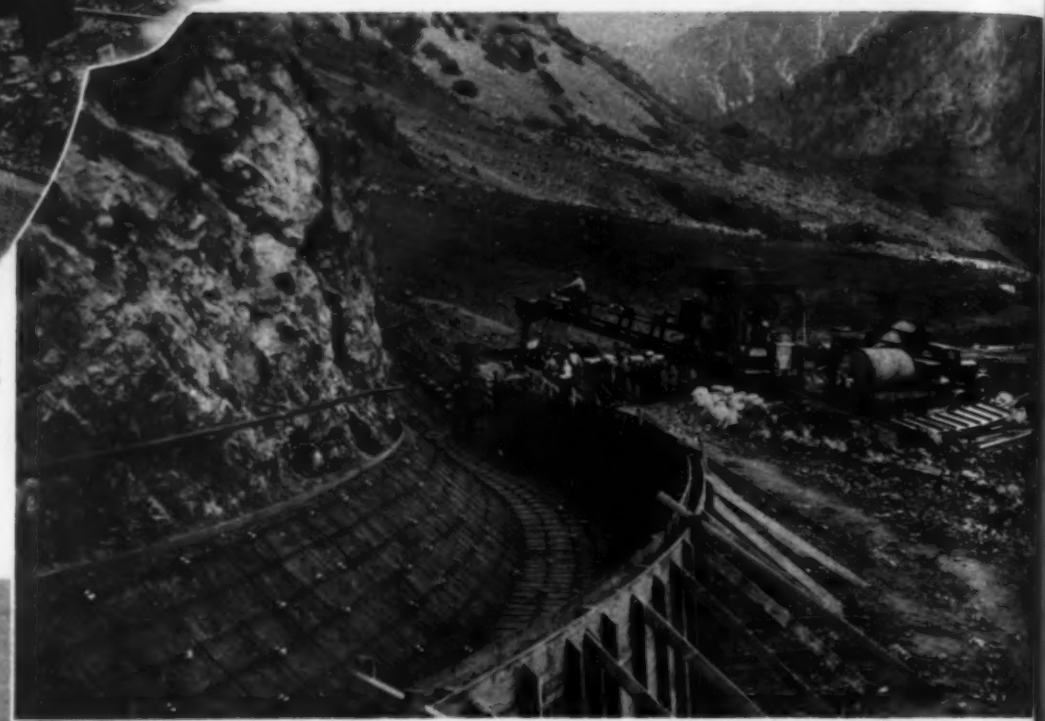
WORK ON 30-FT. FILL *(left)* proceeds steadily night and day with aid of portable generator and floodlights. Scrapers move material from 50,000-yd. cut.

Getting Down to

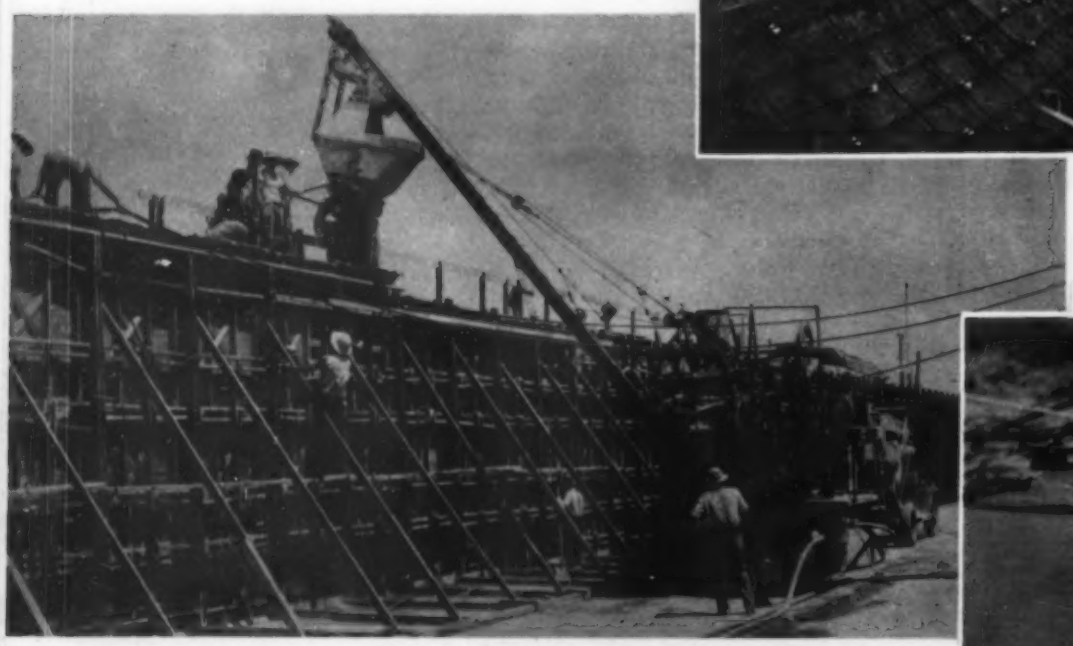
DETAILS

U.S. Bureau of Reclamation Photo

SMALL PLANT comprising portable mixer and platform scales for wheelbarrow batching of sand and gravel supplies concrete through chute to placing trough in open trench on simple section of Ogden-Brigham canal, being built by U.S. Bureau of Reclamation on Ogden River project, Utah. Compare this plant with larger special-purpose outfits at right and below.



BELT CONVEYOR suspended under boom of paving mixer and driven by belt from gasoline motor mounted on boom delivers concrete to flexible spout used in building vertical side wall of Ogden-Brigham main canal on U.S. Bureau of Reclamation's Ogden River project in Utah. Batch truck delivers aggregates to mixer skip.

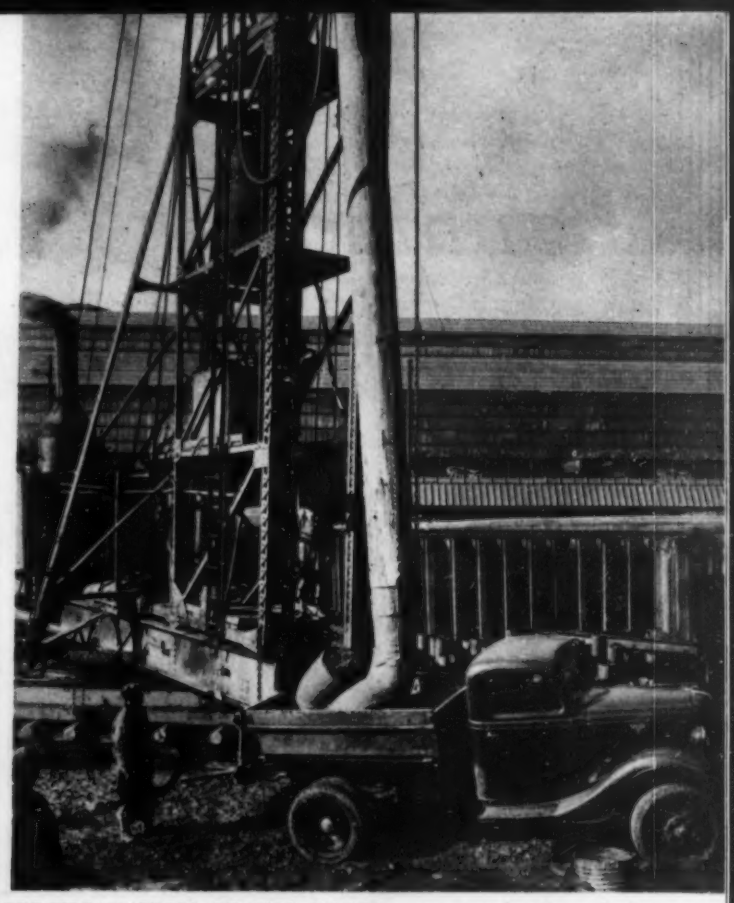


STEEP-ANGLE BOOM of paving mixer equipped with special bucket for vertical placement of concrete serves U.S. Engineer Department in building walls of Alhambra Wash storm drain in Los Angeles County, Calif., under direction of U.S. Engineer Office, Los Angeles District. Mixer moves back and forth along wall to maintain plastic concrete in monolithic section at uniform level. Batch trucks haul aggregates from central plant. Boom and bucket rig is known as "Monkey on a string".

SIEVE BOX *(left)* sifts white portland cement on fresh concrete behind finishing machine to form permanent traffic line on New Jersey concrete paving job of P. Camillo & Co., Westfield, N. J. After wetting white cement by sprinkling with brush *(above)* finisher trowels material into concrete, getting penetration of about 1/8 in. After entire slab has cured for 24 hr. under cocoa mat covered by waterproof rubber sheet, white traffic line is painted with protective seal coat of curing compound applied by brush. Traffic lines constructed by this method have given satisfactory service in New Jersey for more than two years.

Close-Up Shots of Job Methods and Equipment

MOWING MACHINE attached to side of motor truck trims grass and weeds from road shoulders for California Division of Highways.



PRE-EXCAVATION OF PILE HOLES to prevent heaving of clay soil when mandrel drives corrugated steel shells of Raymond step-tapered piles more than 100 ft. to bedrock at Rouge plant of Ford Motor Co. is carried out by hollow cylinder designed to lift clay core with aid of suction. Vacuum tank on upper platform of pile-driver is connected to top of cylinder. After cylinder has been driven short distance into soil, vacuum is turned on, and hammer continues driving to depth of 30 or 40 ft. Cylinder then is withdrawn and swung over dump truck. With suction turned off, about 1½ yd. of clay falls into truck body. Project requires 2,400 piles, most of them spaced less than 3 ft. apart.

WANTED—
Photos of Details

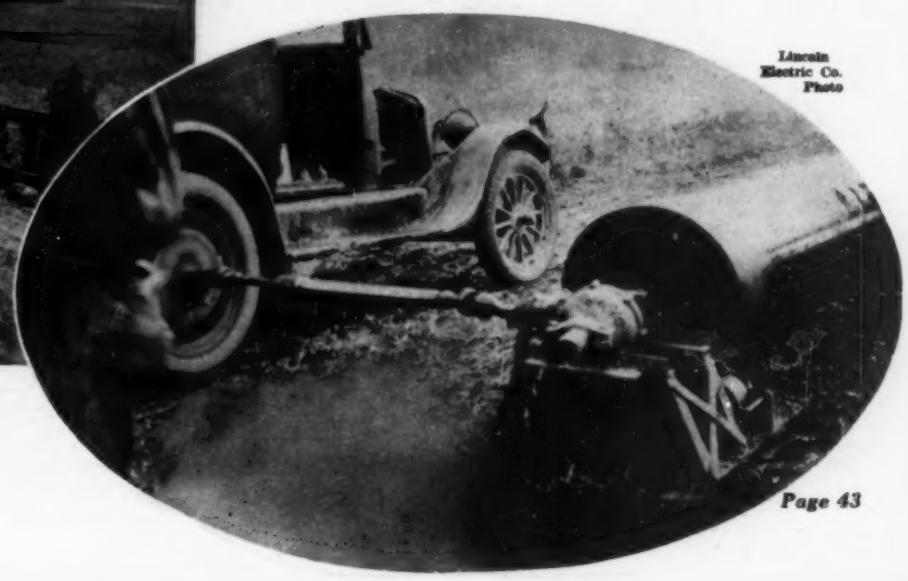
The Editor of Construction Methods wants photographs or sketches illustrating interesting **DETAILS** of method or equipment and will pay for those he finds acceptable for publication.

Hasn't your job produced some **DETAIL** that might be illustrated on this page? Send along a picture of it; we'll return it promptly if we can't use it.

THREE TIRES *(right)* tied to side of highway broom level center-line windrow ordinarily left by broom when brushing one-half of roadway. Device is used by California Division of Highways

STREETCAR FARE METER operated by cord within easy reach of truck drivers registers loads dumped by Euclid Trac-Truks into hog box for hydraulic sluicing into dike being built by Arthur A. Johnson Corp. at Quabbin reservoir, Mass., for Metropolitan District Water Supply Commission.

PIPE-TURNING RIG *(below)* improvised from rear end of old Ford car and attached to rear wheel, jacked off ground, of standing automobile revolves 22-in. steel pipe for Michigan Gas Transmission Co.'s 230-mi. line to Detroit. While man at throttle of car controls speed of revolution, workman walking along pipe pours hot bituminous enamel coating.



Lincoln Electric Co. Photo

TENTH OF A SERIES OF ARTICLES

Planning and Plant for

HEAVY CONSTRUCTION

Principles and Practices of Job Layout and Selection and Use of Equipment for Large Dams and Appurtenant Works

By ADOLPH J. ACKERMAN and CHARLES H. LOCHER

Construction Plant Engineer *Construction Consultant*

TENNESSEE-VALLEY AUTHORITY, KNOXVILLE, TENN.

. . . 10 . . .

Diversion of Rivers

[CONTINUED]

Making Final Closure

Saguenay River Diversion Most Difficult in History

PROBABLY the most difficult river diversions ever attempted were made on the Saguenay River in Northern Quebec, Canada. The first one occurred in 1924 in connection with the construction of the Ile Maligne dam by F. H. Cothran. This river has a normal low-water discharge of 25,000 sec.-ft. (15,000 sec.-ft. minimum) and at flood times exceeds 225,000 sec.-ft. The bed is solid granite and the river is virtually a series of rapids, with velocities in places reaching 30 ft. per second. Construction of the diversion barrier was planned for a stretch of comparatively quiet water and a heavy rock fill was built out into the river three-fourths of the way with satisfactory results. This rock fill extended a considerable distance up and down stream and was formed by side-dumping from railroad cars, the track being shifted outward as the fill progressed.

Eventually, however, the water became so swift that it was impossible to hold the material. Huge boulders, dropped into the constricted channel, were carried away as though they were logs. Fifteen-ton rocks, tied together with steel cables, disappeared in the turbulent water. Steel cables 1 in. in diameter, attached to structural steel cribs built up of heavy I-beams, broke like strings. Blocks of concrete which were dumped into the water did not settle down to choke the channel, as was expected, but were carried off and deposited on the bottom a considerable distance down the river.

The fight with the river was temporarily suspended while an entirely new line of attack was developed. It consisted of building near the uncompleted section of the barrier a diversion channel deep enough to draw the water automatically into it once the inlet had been opened. The diversion channel was 500 ft. long and varied in depth from 25 to 40 ft. Of this length, 320 ft. of channel were excavated by steam shovel, leaving solid rock dikes at each end which it was planned to blast away when everything was in readiness. In the center portion of the channel concrete piers were constructed with grooves for supporting closure gates which offered a simple means of stopping the water whenever desired.

The most spectacular feature of this work was the necessity of blasting away the upstream and downstream dikes, or bulkheads, so thoroughly that none of the rock remained in place. The new channel was thus created within a few moments. The upstream dike contained 14,700 cu. yd.

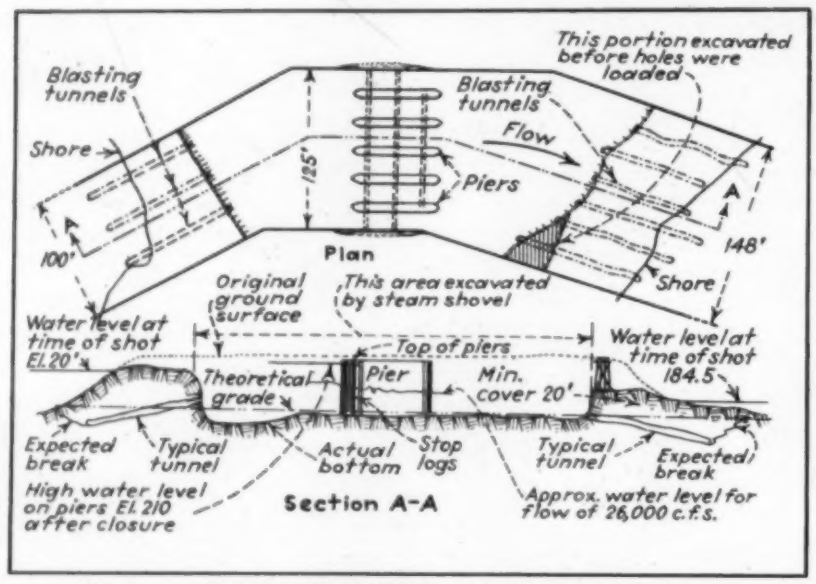


Fig. 1 . . . DIVERSION CHANNEL and closure control piers at Ile Maligne dam on Saguenay River in Canada, showing explosive filled tunnels for blasting dikes.

Fig. 2 . . . OBELISK *(above)* at Chute-à-Caron, with face shaped to fit contour of river bed. Diversion channel is shown at right.

Fig. 3 . . . BLASTING *(left)* pedestal of obelisk tips monolith into river.

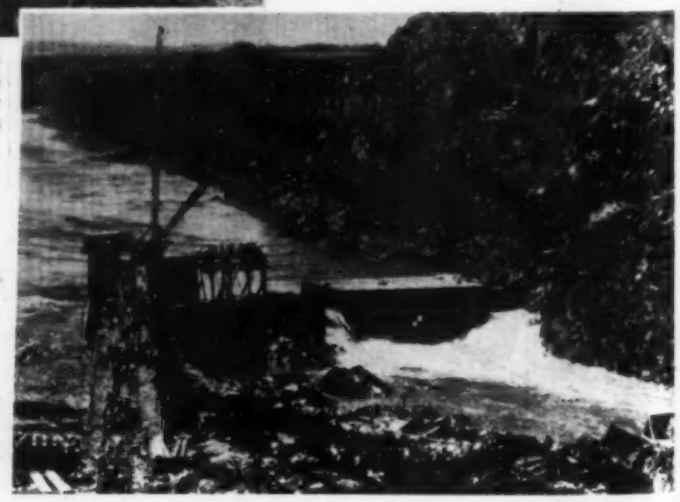


Fig. 4 . . . AFTER BLAST *(right)* obelisk lies in horizontal position ready for sealing with stop logs, rock and gravel.

of rock, and the downstream one 17,500 cu. yd. Two months were required to dig nine tunnels under these dikes at various locations. These tunnels were heavily loaded with dynamite, 205,000 lb. of explosives being used, or an equivalent of about 6 lb. per cubic yard of rock. Fig. 1 shows the general plan of this diversion channel. The eventful blast threw away both dikes and scattered them upward approximately 1,500 to 2,000 ft. and deposited them within a radius of ¼ mi. Less than 5 per cent of the blasted rock fell back into the channel.

In order to protect the concrete piers, midway between the two dikes,

Fig. 5 . . . MODEL used to study action of obelisk and cushioning power of water.

river and diversion channel together with the obelisk and related structures. This was thoroughly tested and resulted in the development of experimental data and a theory regarding the cushioning power of water. It was found that no cushioning materials would have to be constructed on the face of the structure, and that the obelisk would not skip over the water or move downstream before coming to rest. In fact every assurance was developed in advance that the obelisk would land in its designated position.

Soundings had been made of the entire rivel bed at the site of the obelisk, and due to the high velocity of

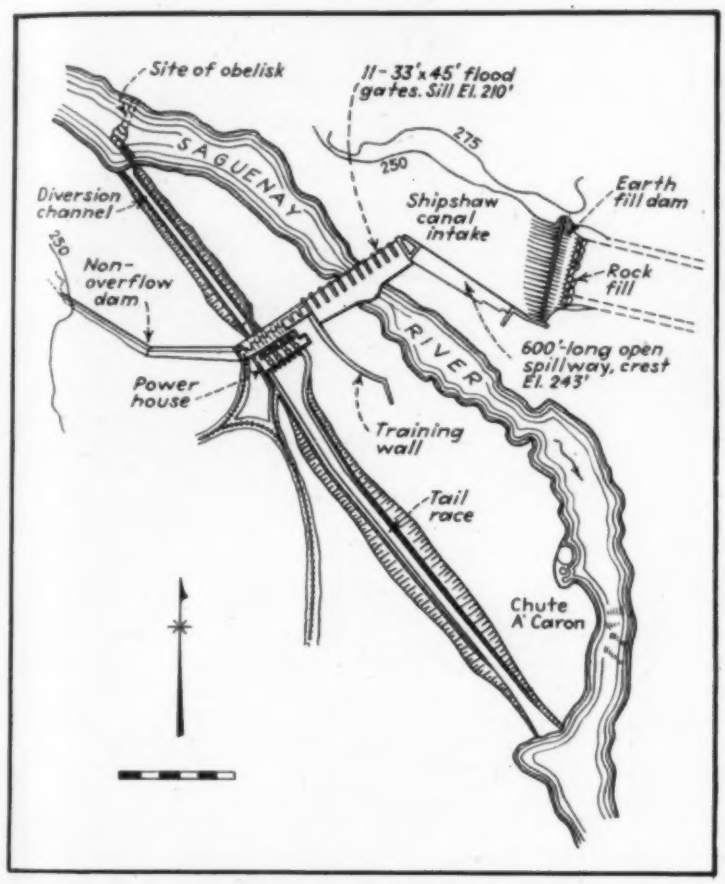


Fig. 6 . . . GENERAL PLAN of Chute-à-Caron project and diversion channel on Saguenay River in Canada.

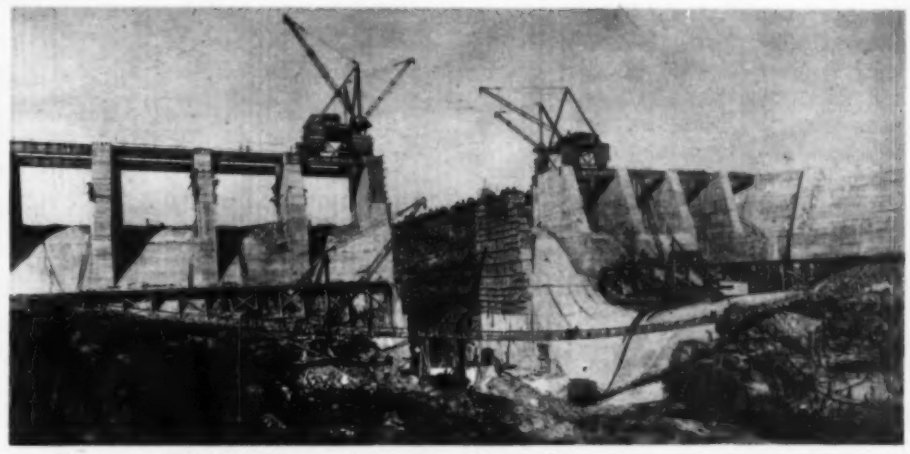


Fig. 7 . . . CONCRETING in river section of main dam under way at Chute-à-Caron.

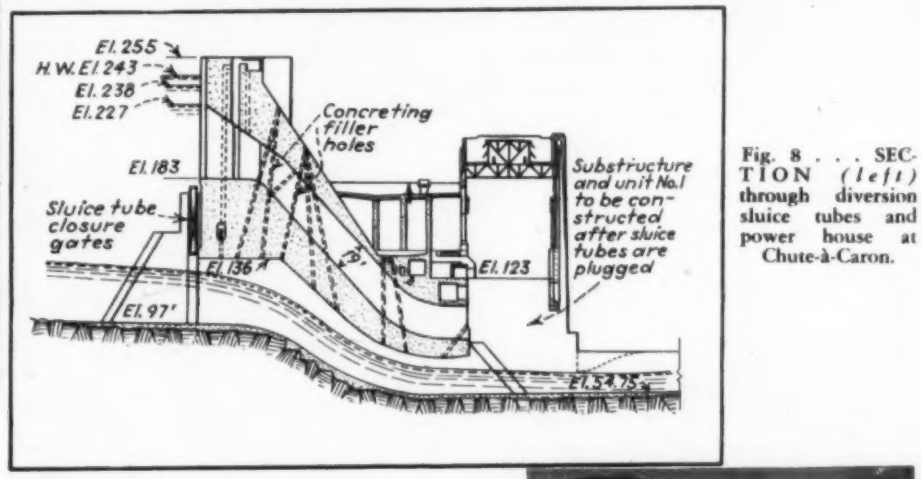


Fig. 8 . . . SECTION *(left)* through diversion sluice tubes and power house at Chute-à-Caron.

35,000 cu. yd. of sand had been dumped around them and filled to a distance of 8 ft. over the top to absorb most of the shock from the blast and to prevent destructive cracking or displacement of the piers. The sand was very effective in preventing damage, and after a jet of water had washed a hole through the sand bank the 35,000 cu. yd. of sand were washed away in 25 min. With most of the river passing through the new channel, it was a simple matter to choke off the remaining flow in the old river bed.

Obelisk For Diversion Of Saguenay River — In 1930 the Saguenay River was diverted for a second time at the Chute-à-Caron project. Figs. 2 to 9 illustrate the operations. At the point where the main dam crossed the gorge the water was 65 ft. deep at low discharge. At this site the water falls very rapidly and the excavation of a special tailrace was justified in order to develop the full head of water for power. This tailrace automatically formed the lower half of a diversion channel. Fig. 8 shows the special passageway constructed under the powerhouse section to carry the river temporarily from the upstream diversion channel into the tailrace.

Construction of the diversion channel and tailrace involved the excavation of 700,000 cu. yd. of earth and 500,000 cu. yd. of rock. The channel was designed to carry 50,000 sec.-ft.; the two diversion tubes under the power house could be closed by means of two gates, each 20x40 ft.

The most spectacular feature of the project was the method of diverting the river out of its natural bed into the new channel. Having in mind the difficulties experienced at Ile Maligne, studies were centered on devising an entirely new method of closure. The bold scheme finally projected by James W. Rickey contemplated the equivalent of building a dam on end on the dry shore and at the desired time blasting away a portion of its supporting pedestal so as to cause this huge structure to tip into the river and come to rest at the desired point of diversion.

The name given this unusual structure in its earliest conception was "obelisk." Since nothing like this had ever been attempted before, practically no design data was available and numerous studies were made on motion pictures of falling chimneys and small blocks of wood, together with comprehensive mathematical analyses of the mechanics of falling bodies. Eventually a hydraulic model was built of the

Fig. 9 . . . DIVERTED SAGUENAY RIVER passing under power house and down concrete-lined diversion channel.

the water — up to 30 ft. per second — this was an exceedingly difficult job. These soundings provided the design data for developing a contoured face on the obelisk which conformed to the shape of the river bed. As finally constructed, the obelisk was 92 ft. high, 45 ft. wide, and 40 ft. at its maximum depth. It contained 5,400 cu. yd. of concrete, weighed 11,000 tons, and was heavily reinforced with steel rods and cables.

It was successfully tipped on July 23, 1930, creating the largest man-made splash in history, in a remarkable setting of thrilled spectators who had come from afar as well as from the entire nearby countryside, lining the hills on both sides of the river to witness this spectacle. The obelisk landed within 1 in. of its designated position. Once in place, it took only 72 hr. to seal the opening at each end and dump rock and gravel along the upstream face until all leakage had been successfully cut off.

Making Closures in A Dam — A combination of diversion and preliminary closure is sometimes used, as was employed by Ross White and F. C. Schlemmer at Norris dam, which is illustrated in Figs. 11 and 12. The same system was also used on Conowingo and Safe Harbor dams. Such partial closures are made where the river has been temporarily passing through low blocks in the dam and the work has reached the stage where it is necessary to raise these blocks. For this purpose a special steel frame or gate is provided, which at Norris dam was 60 ft. long; because of this great span, intermediate cantilever columns were embedded in the concrete to help support the gate.

The gate was handled by an overhead cableway and lowered down in front of an open block until it cut off the water, after which it was rigidly anchored into place and fully sealed by inflating a rubber hose embedded along the edges of the gate. Thereafter, concreting proceeded behind the gate for a new lift of 5 ft. In the meantime, the water was directed through one of the adjacent blocks which was about one-half of the height of the gate lower in elevation than the top of the block being concreted. After the concrete had hardened in this block the gate was transferred to the other one and the water cut off there and thrown back over the newly formed level of the first block, while an additional lift was placed behind the gate in its new position. In this manner the water was thrown from one block to the other and back again until enough head had been developed to pass the river through permanent sluiceways located in the body of the dam. For final closure it was only necessary to close the gates in these sluiceways.

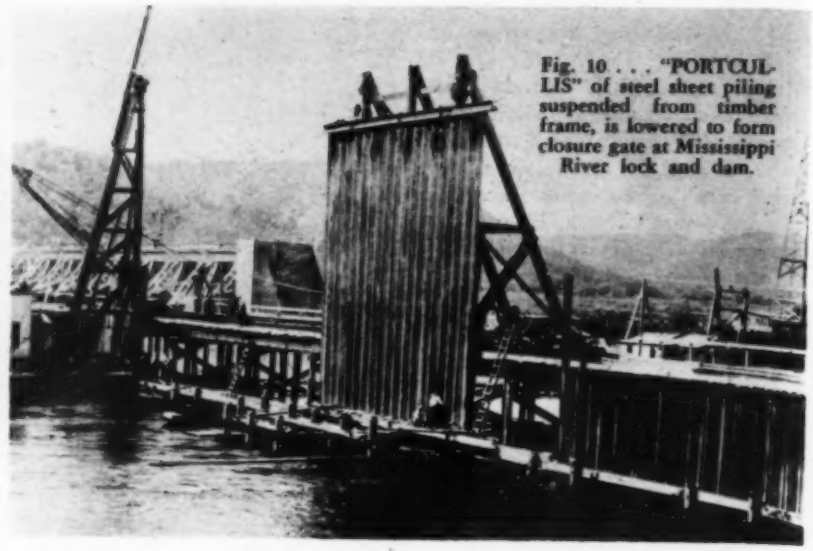


Fig. 10 . . . "PORTCULLIS" of steel sheet piling suspended from timber frame, is lowered to form closure gate at Mississippi River lock and dam.

Fig. 11 . . . LOWERING 60-ft. wide diversion gate in front of low block in Norris dam.

Fig. 12 . . . DIVERSION GATE in place and sealed ready for concreting. Cantilever beam in center halves structural span of gate.

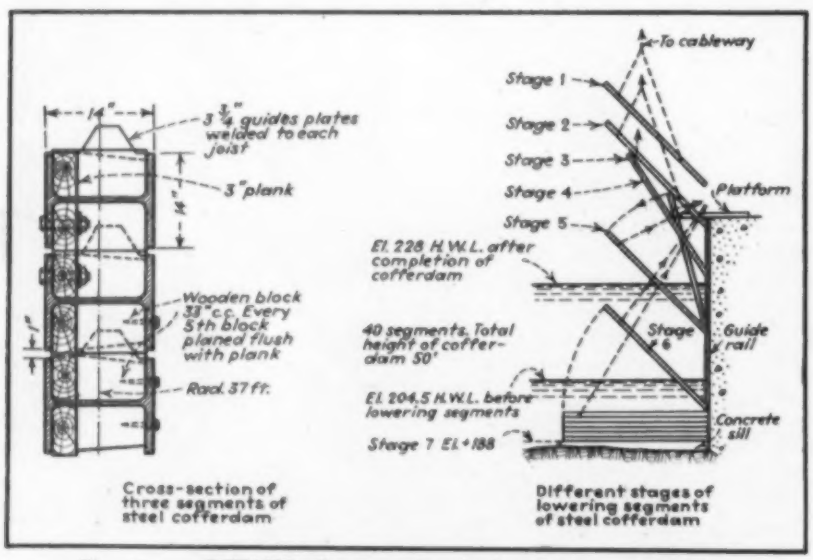

To cableway
Stage 1
Stage 2
Stage 3
Stage 4
Stage 5
Platform
El. 228 H.W.L. after completion of cofferdam
40 segments. Total height of cofferdam 50'
Stage 6
Guide rail
El. 204.5 H.W.L. before lowering segments
Concrete sill
Stage 7 EL+188
3 3/4" guides plates welded to each joist
3" plank
Wooden block 33" c.c. Every 5th block planed flush with plank
Rad. 37 ft.
Cross-section of three segments of steel cofferdam
Different stages of lowering segments of steel cofferdam

Fig. 13 . . . DETAILS of segmental arch ring closure on Krangede dam in Sweden, illustrated in sketches on opposite page showing timber seal (at left) and guide rails (at right).

Closure with Sheet-Pile Portal Gate — Fig. 10 shows a novel form of closure developed by Lazarus White, of Spencer, White & Prentis, New York contractors, on Lock and Dam No. 6 on the Mississippi River. The contractor on this project had originally constructed the locks located on the Wisconsin side of the river and was subsequently awarded the contract for the dam for which the construction procedure required building the first half on the Minnesota side, then diverting the river to the completed section and subsequently building the remaining half of the dam on the Wisconsin side. The contractors decided to use the same concrete plant and other facilities that had been employed on the locks and gain access to the cofferdam on the other side of the river by means of a construction trestle which is shown in the photograph. This trestle was so located that its downstream face coincided with the outer face of the cofferdam structure and the line of sheet piling was placed against the face of the trestle, as is shown in the photograph where the driving of piling is in progress.

The unusual feature on this project was the closure gate, or "portcullis" 42 ft. wide and built up of steel sheet piling about 45 ft. long. After the line of piling had been driven to grade on each side of the closure gate and slightly overlapping the gate, final closure was made by lowering the gate, which was suspended from a special timber frame. There were two impor-

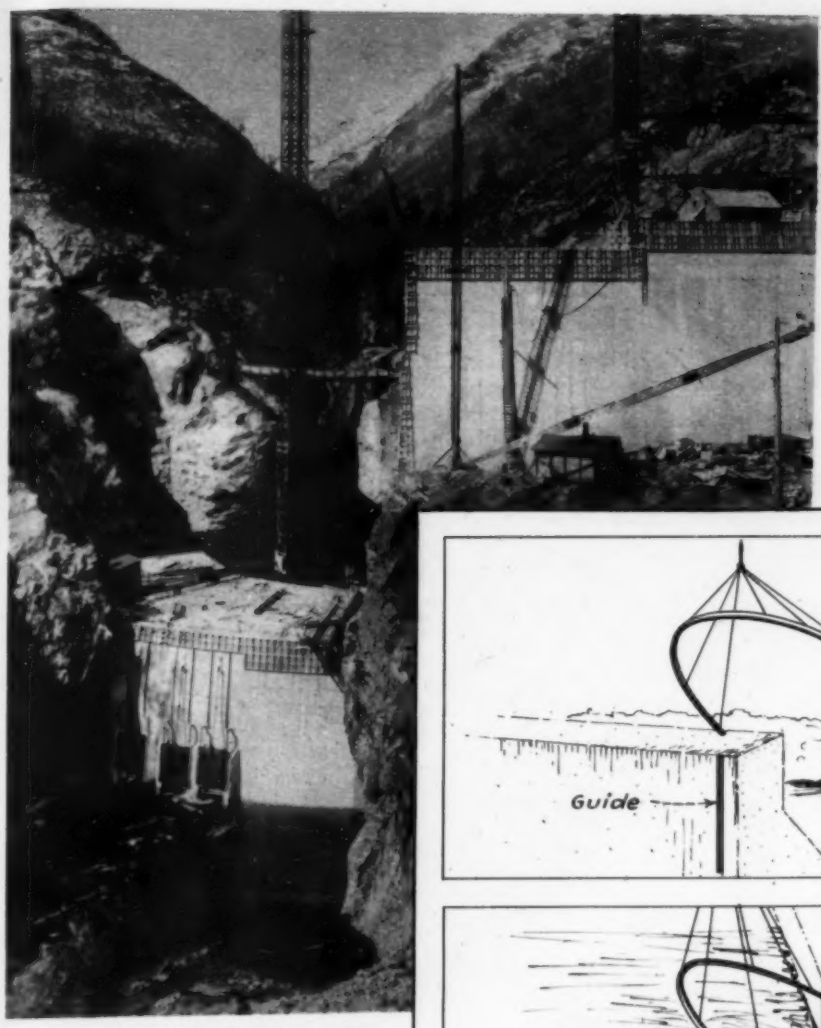


Fig. 14 . . . CLOSURE GATES on rollers at inlets to diversion tubes on Diablo dam ready for lowering when dam is completed and ready to store water.

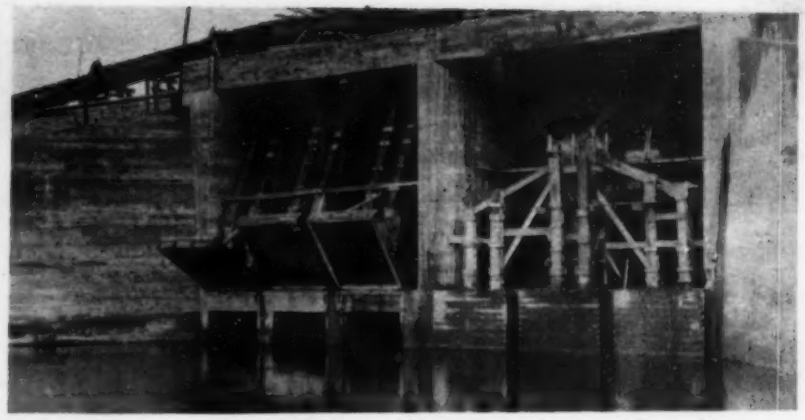


Fig. 17 . . . FLAP GATES on Alcona power house ready to be dropped, with three already in place. Note tremie chutes for placing concrete plug behind gates.

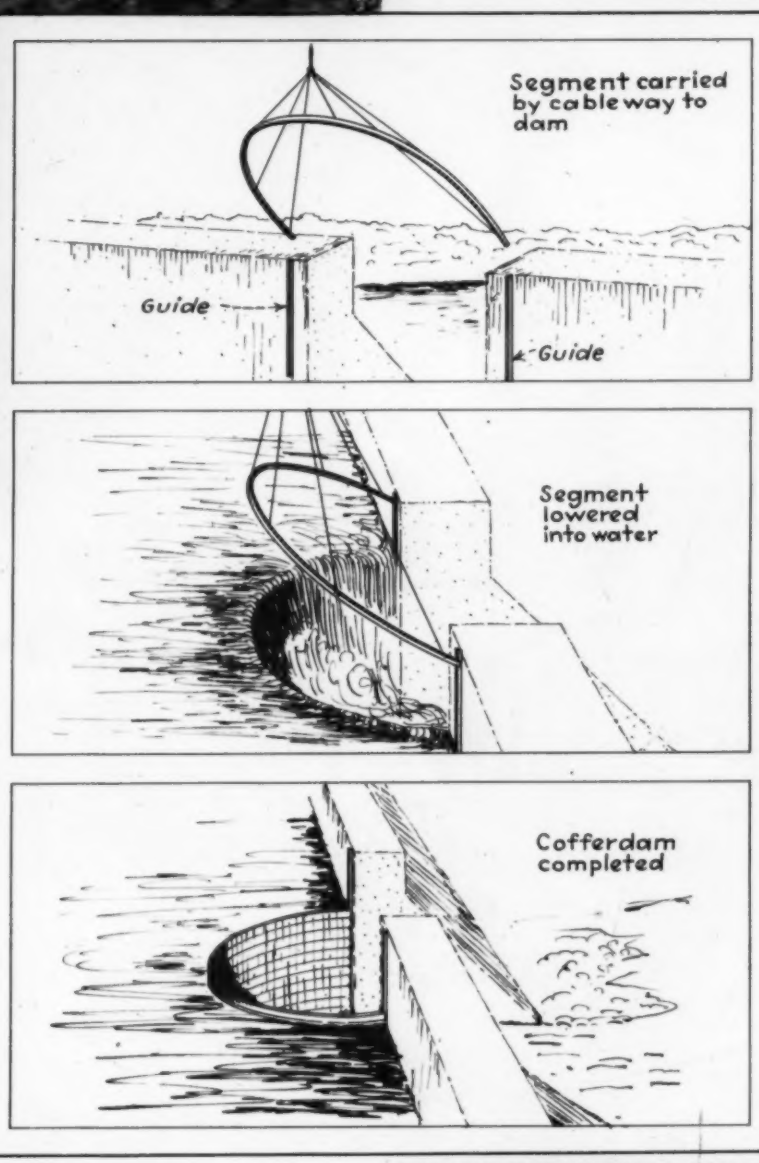


Fig. 15 . . . SEGMENTAL ARCH RINGS form closure on Krangede dam in Sweden.

tant features on this closure gate: One was a waler tied to the lower edge of the gate which kept the piling from being deflected downstream by the water, the waler sliding along timber piles which had been driven in preparation for the closure. The other noteworthy point was that the closure gate was located on the downstream side of the trestle; this location prevented severe turbulence at the outlet from undermining the trestle.

Closure by Means of Segmental Arch Rings—A novel method of closure which is destined to greater application in the future was employed on the Krangede dam in Sweden and was described in *The Engineer* of London, March 20, 1936. The problem consisted of closing two openings each 66 ft. wide against a total head, after closure was completed, of 40 ft. The sketches in Fig. 15 show the general methods. Each segment consisted essentially of a 14x14-in. H-beam which was first cut in half at the center of the web, after which the flanges were bent to a radius of approximately 37 ft. and the two parts then welded together. A timber seal was bolted to the upstream side as shown in Fig. 13. The actual closure took about as many days to build as an ordinary operation would have required in months. The two ends of these segments were arranged to slide along guide rails along the face of the dam as shown diagrammatically.

There is every indication that this system may be used to advantage for periodic unwatering of the upstream face of a dam for inspection purposes if it is originally equipped with a system of guide rails to support the ends of the segments.

Final Closure Gates for Filling Reservoirs. — Fig. 14 shows a special type of closure gate on rollers employed on the Diablo dam to shut off the temporary openings which carried the water during construction. Fig. 16 shows a special gate built on the job for a similar purpose at Coolidge dam. This gate was sufficiently heavy to assure closure and support a large head of water before the opening through the dam was filled with concrete. At Dix River dam a special type of hemispherical steel gate was employed because of the unusually large opening. It operated in the form of a hinged gate supported at the top and lowered down in front of the opening on the day of closure.

Fig. 17 shows a simple type of flap gate at Alcona dam, normally stored in a vertical open position and dropped into place by cutting the supporting wires when the reservoir was ready for impounding. These gates were of very simple construction of a combination of I-beams and timbers and, contrary to expectation, such gates do not slam shut with an impact but merely drop in the water which carries them against their seat at slightly higher velocity than the water itself had while passing through the openings. As soon as these gates were in place the space behind them for a limited distance was filled with concrete through the tremie chutes shown in the photograph.

♣

NEXT MONTH — Chapter 11 of the series on "Heavy Construction," by A. J. Ackerman and Charles H. Locher, to appear in the October issue, will deal with "Pile Driving and Cofferdam Unwatering."

Fig. 16 . . . SPECIAL CLOSURE GATE at Coolidge dam shortly after it had been lowered into place to impound water in reservoir.

VIBRATION

TRACTOR ENEMY NO. 1

It is a universal law that marching soldiers must break step while crossing a bridge—to avoid the destructive effects of VIBRATION. Unless CONTROLLED — vibration can be just as destructive in tractors.

CONTROL MAKES THE DIFFERENCE

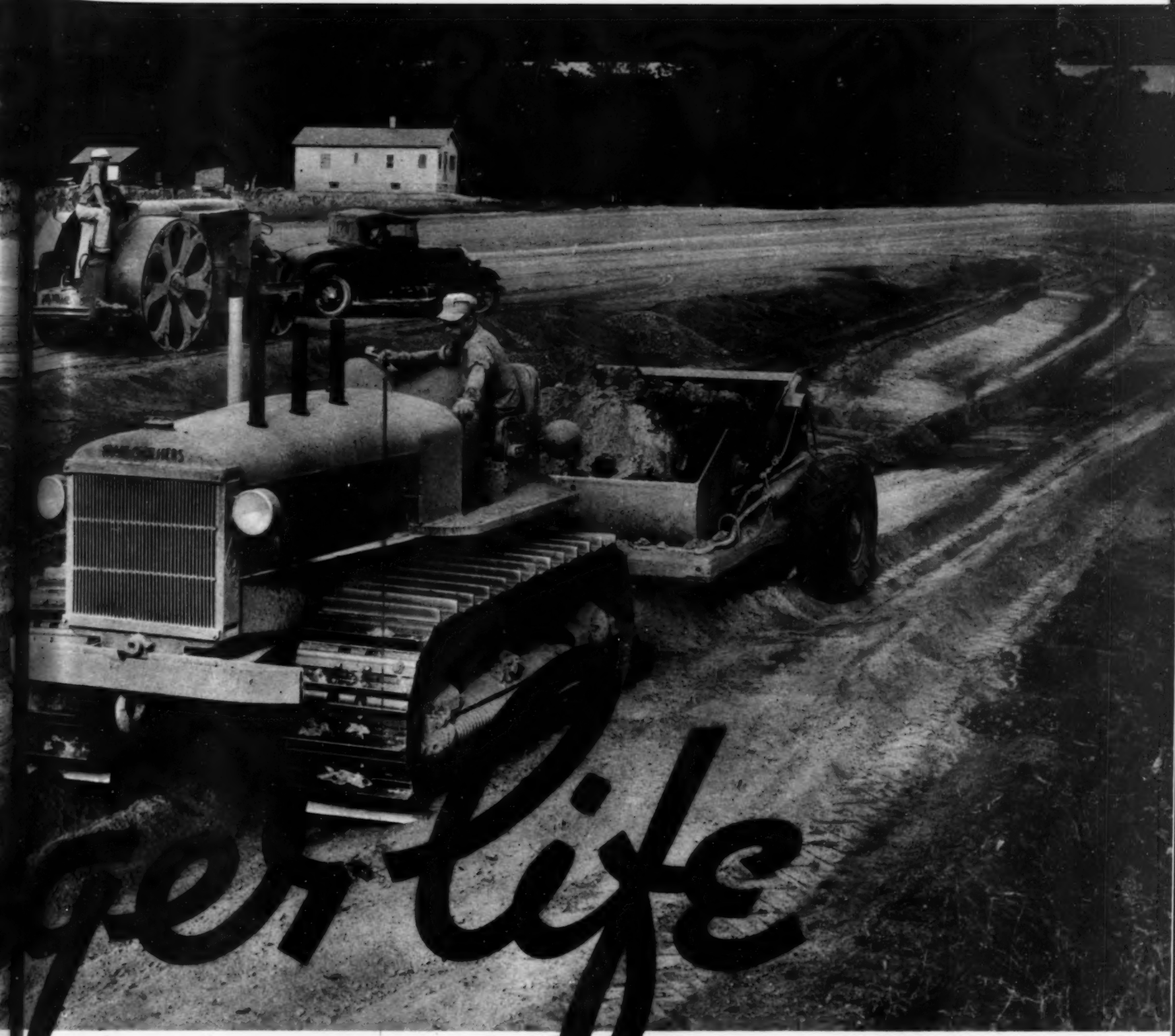
CONTROL MEANS Co

★ CONTROLLED *instant* STARTING
CONTROLLED INJECTION OF FUEL
CONTROLLED AIR-FUEL RATIO
CONTROLLED IGNITION

14 TO 21 HOURS PER DAY

In the construction of a new two-lane highway on U.S. 30 across northern Indiana, the Controlled Ignition Oil Tractors of J. C. O'Connor work 14 to 21 hours a day. Above is one of the Model "L-O's" with 7-yard Continental Scraper. Below is a Model "K-O" leveling the grade.

ALLIS CH
TRACTOR DIVISION—



It is only natural that Controlled Ignition, with its low compression pressures and freedom from destructive vibration, should mean longer tractor life. A typical owner reports that after 7,000 hours of heavy work — in severe dust, 22 hours a day — he had not even replaced the original sleeves and pistons of his first Model "K-O". In a large logging camp — under the most abusive type of work — a fleet of Model "L-O's" worked 3,500 hours and still had their original pistons, sleeves, rings, valves, steering clutches, master clutches, brake bands, main and connecting rod bearings.

Control makes the difference! Controlled Ignition enables Allis-Chalmers Oil Tractors to burn any good grade of low cost Diesel fuel oil with normal compression pressures in the combustion chamber. Thus ... abnormal stresses and strains on metals and working parts are avoided. There is no need for heavy, unbalanced construction, no special high pressure bearings, no high tension rings, no heat reservoirs in the combustion chamber, no special lubricating oil. You profit from using low cost Diesel fuel without sacrificing instant starting, balance and low upkeep. See an A-C dealer.

FACTORY BRANCH AND DEALER SERVICE EVERYWHERE

CHALMERS *Controlled Ignition* OIL TRACTORS

SION—MILWAUKEE, U. S. A.

HIGH-EARLY-STRENGTH CEMENT

Speeds Half-Width Paving in Pennsylvania

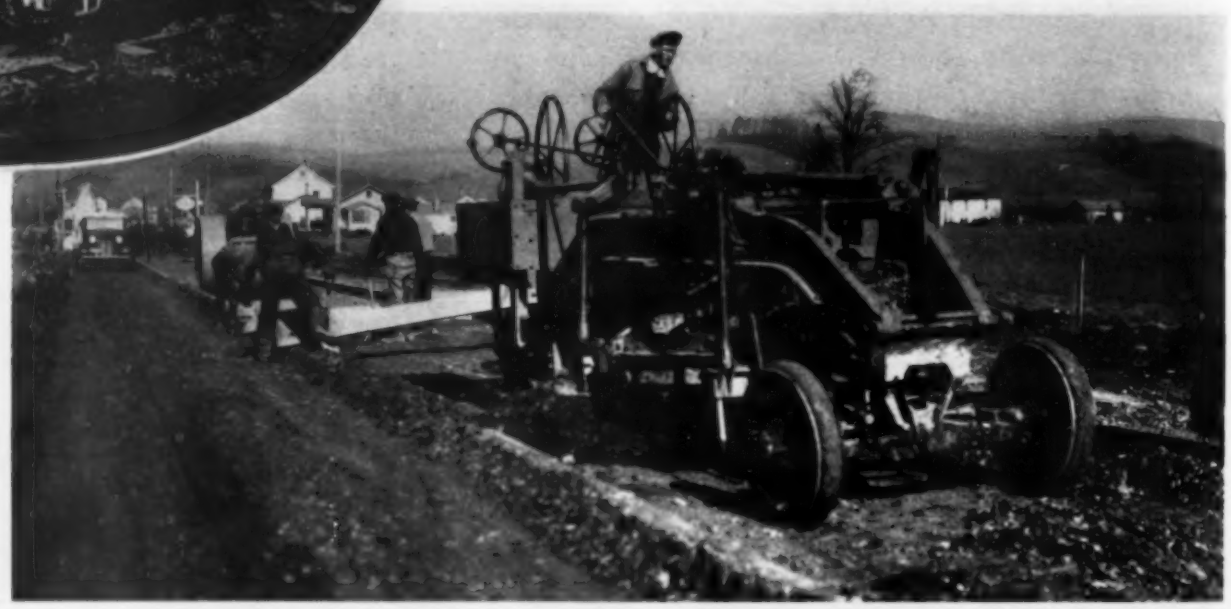
ONE-WAY TRAFFIC is maintained through concrete paving project *(left)* built during November and December on Susquehanna Trail north of Williamsport, Pa. Concrete is made with high-early - strength cement and calcium chloride admixture. Paver travels on shoulder.

AS IS CUSTOMARY on Pennsylvania projects involving concrete paving of main routes where satisfactory detours are not available, a contract executed by F. D. Kessler, Inc., of Northumberland, Pa., called for use of high-early-strength cement and maintenance of traffic during construction of a 1.06-mi. section on the Susquehanna Trail (U.S. 111) 5 mi. north of Williamsport. In spite of a late fall start and the added handicap of much wet weather, the Kessler organization completed one lane and laid half of the second in advance of the December freeze-up. Because of the low temperatures prevailing, the State Department of Highways permitted a calcium chloride admixture with the high-early-strength cement. Efficient equipment well adapted to the work and maintained in excellent condition aided the contractor in pushing the work under adverse conditions. Two-way traffic was maintained through the project during the winter.

SELF-PROPELLED SCREED riding on forms strikes off first course of concrete 2 in. below finished grade to permit placing of bar mat reinforcement. Temporary radiator is hooked up to gasoline engine to replace original radiator damaged by passing motorist driving at night on wrong side of slab.

Preliminary Work — This paving project closes the last gap in smooth high-type surface on U.S. 111 north of Williamsport. Before building the grade for the new pavement, the contractor scarified high-crown bituminous macadam which occupied most of the project and broke up old concrete slab on the remaining 250 ft. by dropping a 2,500-lb. weight on the whip line of a crane. A monkey line attached to the weight, which was salvaged from an old generator, kept the casting from turning. Repeated dropping with the heavy weight pulverized the concrete. About 75 ft. of the pulverized concrete had to be removed with a clamshell, but the remainder was left in place to be buried under the new highway embankment, as also was the scarified macadam.

About 14,000 cu.yd. of fill was required to raise the grade for the new pavement. Excellent shale for this fill was available in a hillside bordering a school playground about ½ mi. from the north end of the project. A Lorain 1¼-yd. gasoline shovel widened the playground and loaded the borrowed shale into trucks. After being dumped in the fill, the material was spread by a hydraulically operated bulldozer mounted on a 35-hp. diesel tractor and was compacted in 8-in. layers by a 10-ton roller, as required by specifica-



TRACK-TYPE MOTOR GRADER shapes subgrade and maintains earth roadways for batch trucks and highway traffic.

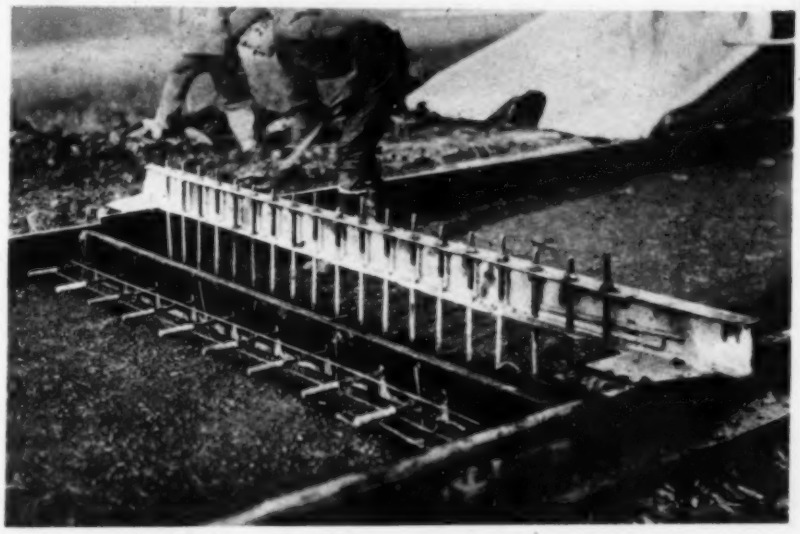
FINAL SUBGRADE TRIMMING is guided by templets resting on steel road forms.

EXPANSION JOINT is assembled on job by placing premolded filler in trough-shaped basket of welded bars and inserting dowels through holes in filler material. Dowels are clipped to transverse bars of basket and to second (upper) pair of parallel rods

tions. The maximum depth of fill was about 7½ ft.

Pavement Design — On the compacted fill, the contractor built a 20-ft. concrete pavement of 9-7-9-in. cross-section in half widths of 10 ft. each, leaving one-half the road open at all times for single-lane traffic. Bar mat reinforcement was incorporated in the slab 2 in. below the surface. These mats were made up of ⅜-in. round deformed longitudinal bars and ¼-in. round transverse spacing bars. The mats were 16 ft. long and were lapped 1 ft.

SLOTTED END GUIDE *(right)* with broad bottom flange anchored under base of road form holds expansion joint filler and shield in position during joint erection and concreting.



PINNED IN POSITION and protected by shield, expansion joint is ready for placing of concrete. Near side of dowels has been dipped in asphalt paint and ends of bars have been covered with 4-in. ferrules containing 1-in. corks to allow movement of steel.

ROAD CONSTRUCTION *(left)* is directed by F.D. Kessler, at left, contractor, and W. J. Anderson, resident engineer for Pennsylvania Department of Highways.

Expansion joints of a type differing from that formerly specified by the Pennsylvania Department of Highways were called for at intervals not to exceed 77 ft. A spacing of 76 ft. between joints was chosen by the contractor to fit in with the length of bent steel plates utilized in making a keyed and dowelled longitudinal joint against the smooth surface of the inside road form on the first concrete lane constructed.

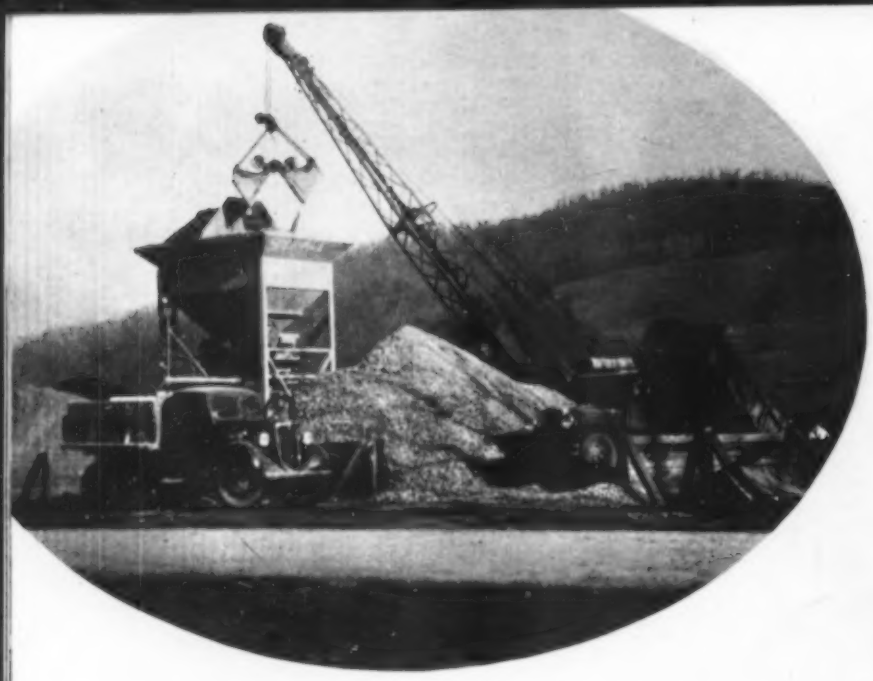
As indicated by accompanying photographs, the new expansion joint is supported by a prefabricated frame of bent ⅜-in. bars (or chairs) to which straight ⅜-in. transverse bars are welded. On the chairs of this frame is set a strip of ¾-in. premolded asphalt-impregnated filler supported in a metal shield. Dowel bars ¾ in. in diameter and 2 ft. long are inserted through the holes in the filler and clipped to the transverse bars. The clips also fasten in place a second set of transverse bars which rest on the dowels.

One end of the dowels is dipped in asphalt paint. On this end is slipped a 4-in. ferrule into which a 1-in. cork has been inserted. The asphalt paint prevents bonding to the concrete, and the cork in the end of the ferrule provides for movement of the dowel. The entire assembly is designed to transmit vehicle loads across the joint from one slab to the next, averting joint failures and slab settlement at this weak point in the pavement. Dowel rods are spaced 12 in. apart and 6 in. from the edge of the concrete, a 10-ft. lane requiring ten dowels.

Concrete Paving — In addition to heavy local travel, the Susquehanna Trail carries a large volume of through traffic between Central Pennsylvania and New York State. During construction of the project, traffic through the work ranged between 1,000 and 2,000 vehicles a day. The contractor kept as much of the project as possible open to two-lane travel but passed the traffic through the construction zone in a single lane on one-half of the road. A 25-hp. motor grader shaped the subgrade and maintained earth driveways for traffic and for batch trucks.

To keep the subgrade clear for setting construction joints in advance of paving, the contractor operated his Foote 27E mixer on the shoulder adjacent to the lane being concreted. Loaded batch trucks backed along this shoulder to the mixer. After dumping, the trucks pulled off the shoulder 200 or 300 ft. ahead of the paver, where the forms were broken for this purpose. As required by Pennsylvania's 1936 specifications, forms for both the 9-in. outside edge and the 7-in. center-line edge had an 8-in. base. After frosts became severe, the subgrade was protected at night with cotton mats.

Concrete placed on the subgrade was struck off 2 in. below the finished surface by a self-propelled gasoline-driven screed riding on the forms.



1-CU. YD. CLAMSHELL *(left)* on 45-ft. boom handles sand and crushed rock from stockpiles to overhead bins. Dump trucks haul aggregates to plant.

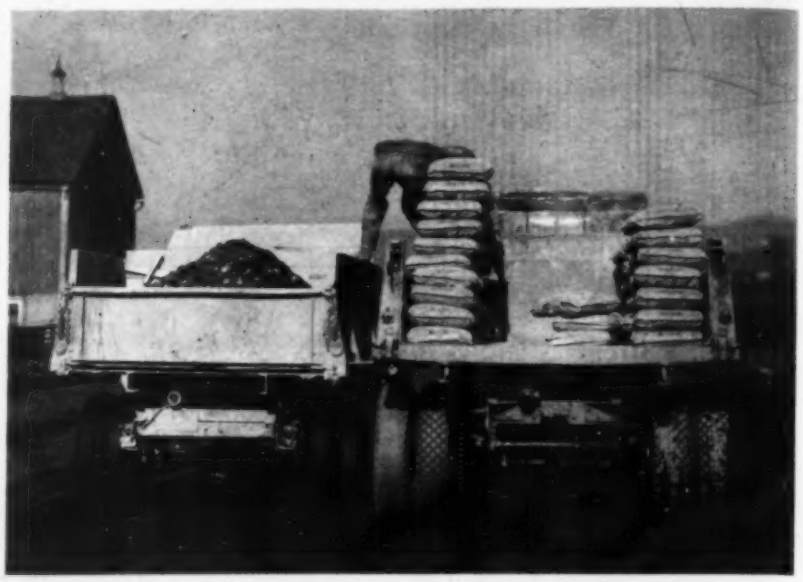
According to Mr. Kessler, this machine, built to his order by the Ransome Concrete Machinery Co., saves time, labor and interference with other operations and pays for itself on each 2 mi. of concrete pavement laid. It never gets in the way of either joint setters or steel setters.

After the paver had covered the reinforcing steel with the top 2 in. of concrete, an Ord finishing machine struck off the surface, which then was floated, edged and covered with burlap. For added protection against frosty nights, the wet burlap was covered at the end of the day with about 1 ft. of straw. The pavement was opened to traffic when beam breaks gave a modulus of rupture of 550 lb. per square inch. This requirement was met in from 2 to 5 days, depending upon the atmospheric temperature.

Concrete Design—Concrete for the pavement was designed on nominal volume proportions of 1:2:3½ using a six-bag batch with 1,890 lb. of dry crushed limestone coarse aggregate and 1,236 lb. of sand (with a 3 per cent moisture content included) as the fine aggregate. All dry materials were weighed. The batchmeter on the mixer was locked for an 83-sec. cycle.

A 2 per cent solution of calcium chloride is specified by the Pennsylvania Department of Highways for concrete made with ordinary portland cement, but the use of calcium chloride is prohibited in warm weather in concrete made with high-early-strength cement. In warm weather, the latter concrete with calcium chloride added sets too rapidly to be handled and finished properly. On the Kessler contract, however, because of the low atmospheric temperatures prevailing, the state highway engineers permitted a 1 per cent solution of calcium chloride (1 lb. of calcium chloride to each 100 lb. of high-early-strength cement) to hasten hardening of the concrete.

Batching Plant—Sand and crushed rock were hauled by truck to a batching plant at the south end of the project, where the trucks dumped the aggregates within reach of a Lorain crane handling a 1-yd. clamshell on a 45-ft. boom. The crane stockpiled the materials and transferred them to 58-ton Heltzel steel overhead bins. Batch trucks backed under the weighing apparatus to be loaded.



HIGH-EARLY-STRENGTH CEMENT in sacks is transferred directly from cement truck to batch truck on way to mixer.

AFTER MECHANICAL STRIKE-OFF *(right)* has leveled first course of concrete 2 in. below finished grade; workmen place bar mat 16 ft. long.

FINAL SURFACE FINISH *(left)* is obtained with finishing machine followed by skilled hand finishers.

Progress—Excavation of borrow for the fill was begun on Oct. 8, 1935, and the grade was ready for the start of paving on Nov. 5. Frequent rains delayed construction, and in the next two weeks the contractor had less than 4 full paving days, in which the organization placed 3,000 lin. ft. of 10-ft. width. Paving of the first lane was completed in 5 days, and 2½ additional paving days sufficed to lay 2,500 lin. ft. of the second lane before the job had to be shut down for the winter. Altogether the contractor used last fall only 13½ days of the 70 days legal time provided by the contract. Paving of the second lane was completed in 5 days in the spring.

Direction—H. H. Temple is chief engineer of the Pennsylvania Department of Highways. Under the general supervision of S. W. Jackson, district engineer, Williamsport, Pa., the work on this project was directed for the Department by W. J. Anderson, resident engineer. F. D. Kessler was in active charge of construction, with George Yoxtheimer, superintendent, and Frank Saylor, concrete foreman, immediately responsible for grading and paving operations.

Present and Accounted For —

A PAGE OF *Personalities*

242-MI. AQUEDUCT from Parker Dam on Colorado River to Southern California cities is being built under direction of James Munn, chief of construction for Metropolitan Water District, climaxing 30 years in engineering and construction —with U.S. Reclamation Service, Mokelumne water supply project and Los Angeles Department of Water, among others.

PWA ENGINEERING DIVISION now is headed by Arthur J. Bulger *(below)* who served as assistant director until recent promotion to succeed Jabez G. Gholston, who has been made director of Inspection Division. Mr. Bulger has been assistant director of the engineering division since establishment of PWA in 1933.

CONTRACTORS' EXECUTIVE SAFETY COMMITTEE on Colorado River Aqueduct responds this year to leadership of Chairman C. J. Kavanagh, superintendent for Broderick & Gordon and Three Companies, assisted by Harry Davis, superintendent of Griffith Co., as vice-chairman. Gilbert J. Shea headed group last year.

PRIZE-WINNING BRIDGE carrying Lorain Ave. across Rocky River, Cleveland, designed and constructed under direction of J. R. Burkey (leaning against railing), chief engineer of bridges, Ohio Department of Highways, received award as most beautiful structure in $250,000-$1,000,000 group from American Institute of Steel Construction, represented in Cleveland by Alexander Miller, district engineer, standing on sidewalk beside Mr. Burkey. Bridge was illustrated in *Construction Methods,* Aug., 1936, p.25.

ASSISTANT CHIEF OF ENGINEERS, U.S. Army, is new post of Brigadier-General (formerly Colonel) Max C. Tyler, promoted to present position and rank July 30 by President Roosevelt on recommendation of Secretary Dern of War Department as authorized by law passed by last Congress increasing strength of Corps of Engineers and providing for two assistants to Chief of Engineers. General Tyler has been in charge of river and harbor section in office of Chief of Engineers, Washington, since April 20 of this year.

BARTLETT DAM, concrete multiple arch structure on Verde River, near Phoenix, Ariz., is being built under supervision of Robert F. Herdman, resident engineer in charge of construction for U.S. Bureau of Reclamation. Previous to his government service, Mr. Herdman was associated for many years with Byllesby Engineering & Management Corp., of Chicago.

NEW EQUIPMENT

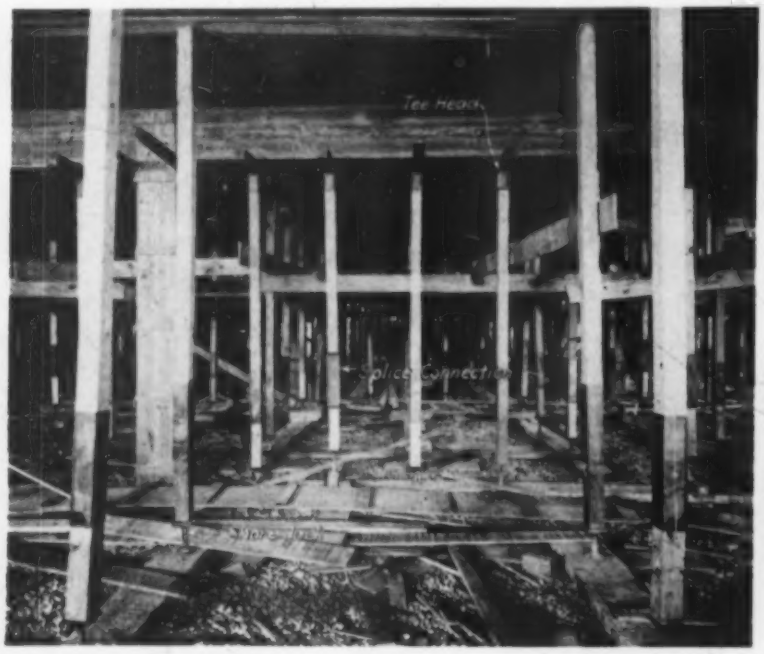
On the Job

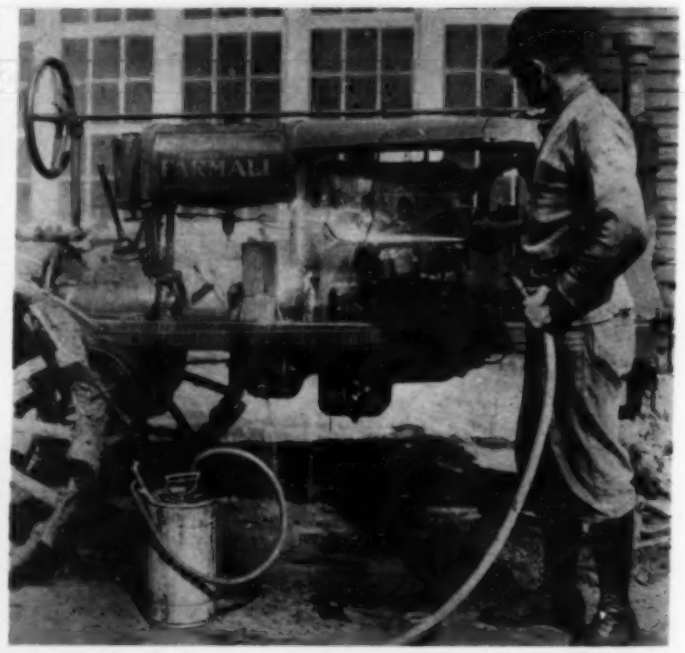
TWO NEW MODELS have been added to Northwest line of convertible shovels. These machines, ⅜ and ½ cu.yd., are full-capacity, full-weight, full-revolving and are mounted on full-length crawlers. Cab is completely inclosed with ample space for inspection and maintenance. Powered by 8-cylinder Ford truck engine equipped with special oversize pump and radiator. Transmission is through set of wide-faced helical gears mounted on anti-friction bearings and running in oil-tight case. All high-speed shafts are mounted on ball or roller bearings. Other features: "Feather-touch" clutch control; Twin Disc clutch connected to flexible coupling; rotating base and side frame cast as unit; all-welded wide-base boom; welded dipper stick; bucket with manganese front and removable teeth; independent crowd utilizing force of dead-end of hoist cable giving greater crowding and engine power for digging. — Northwest Engineering Co., 1727 Steger Bldg., Chicago, Ill.

SCIENTIFICALLY DESIGNED end construction known as "Flang-Lok" *(above)* built as integral part of hose eliminates need of metal couplings, nipples or clamps, which wear rapidly in concrete placing, grouting, sandblasting, dredging and other operations, and results in savings in cost and weight. Especially valuable on heavy, cumbersome sections of hose, reducing time and effort required to joint hose to flange on pump or pipe line. Metal flange on "Flang-Lok" turns independently of hose making mating of bolt holes simple matter. — Goodall Rubber Co., Trenton, N. J.

CONTROLLED IGNITION in this diesel fuel tractor *(left)* enables firing to take place at proper point, assures complete and efficient combustion and eliminates power-wasting pre-ignition. In controlled-ignition tractor, high compression pressures are not present, making high tension rings and specially compounded lubricating oils unnecessary and eliminating excessive weight and destructive vibration. Makers claim that this tractor provides maximum of diesel fuel economy in addition to simplicity, smoothness and balance. Other improvements: New type fuel pump easily accessible for inspection and adjustment; simplified injection system and new cylinder heads.—Allis-Chalmers Mfg. Co., Milwaukee, Wis.

METAL SHORING EQUIPMENT consisting of jack, splice and tee enables builder to erect shores from 2 ft. to any necessary height using short lengths of 4x4-in. timber. It saves time in making up, erecting and stripping and much labor ordinarily spent in leveling and cambering forms. Eliminates need for plates under shores above first floor. Assembled shores may be lifted in one piece and easily stored in yard in minimum space. Jack adjustment of 10-in. relieves worry over settling of mud sill. Easily and inexpensively transported from job to job.— Construction Specialties Co., Oliver Bldg., Pittsburgh, Pa.

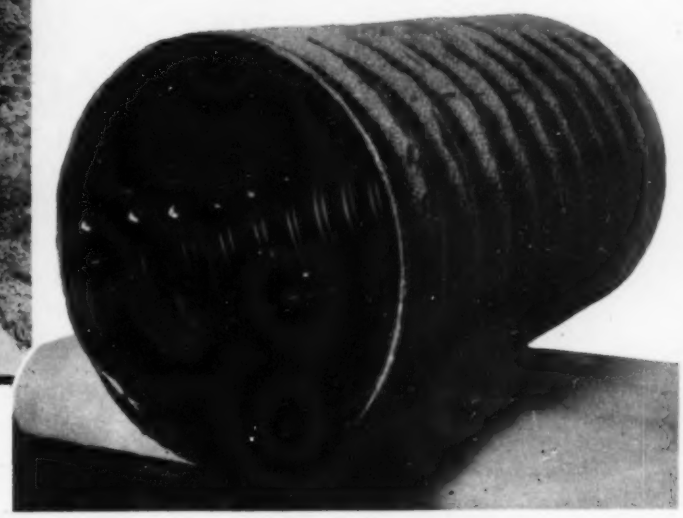




NEUTRAL SOAP *(right)* called "Magnusol" soluble either in water or in solvent such as kerosene, cleans grease and oil-coated machinery of all sorts without harming finishes or painted surfaces. May be used with water only in cleaning trucks, buses or car bodies; with kerosene in removing stains from floors and for cold tank cleaning of truck and automobile parts, using cold solution. Sprayer for efficient application of Magnusol may be purchased.—Magnus Chemical Co., Garwood, N. J.

OPERATOR FATIGUE ELIMINATED by "Speed-o-Matic" power control of operations on shovel-dragline-crane using short, easy-throw levers which also make possible speedier operation and increased output. Power control has no wearing parts between clutches and brakes and conveniently arranged control stand behind which operator is seated at front of cab. Even foot pedals are operated from this position. Large, truck-type seat is adjustable both as to height and proximity to control stand. Furnished on four Link-Belt models.—Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill.

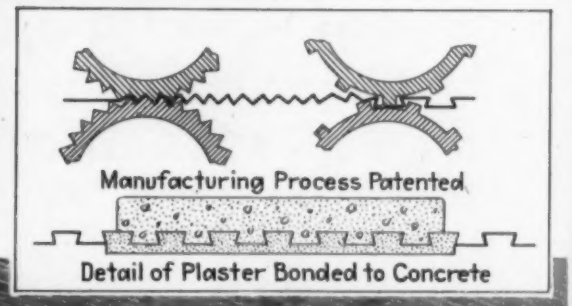
ASBESTOS BONDED PAVED INVERT PIPE *(below)* has been developed by its manufacturer to be used in drainage and sewer systems where most of wear and corrosion is in bottom portion of structures. In this process asbestos fibres are embedded in hot zinc, then saturated with bituminous material after which pipe is coated and paved in usual way. Greater adhesion and 50 per cent increased plastic range lengthen service life of pipe. Although developed primarily for sewer service and severe corrosive conditions, pipe is equally suitable for highway, railway and other drainage structures where high degree of permanence is desirable.—Armco Culvert Mfrs. Assoc., Middletown, Ohio.



8-IN. FLOOR SANDER *(below)*, named "Contractor Special Speedmatic," designed and built especially for floor and building contractors' use where power, speed and finish are required. Powered by new-type 1½-hp. heavy-duty a. c. motor which develops about 4 hp. under load. New adjustable drum includes hardened spiral relieved-type cams which assure abrasive paper economy. Drum unit quickly removed when recovering is necessary. V-belt-driven sander has selective speed feature to deliver maximum production. Oversize fan, traveling at 5,600 r.p.m., picks up dust on backward and forward strokes of machine. Equipped with ball bearings throughout. — Porter-Cable Machine Co., Syracuse, N. Y.

PORTABLE ROCK CRUSHER *(left)* may be mounted on any truck chassis and operated from truck motor by Hercules split-drive power take-off. Machine has capacity of 6 to 10 cu.yd. per hour and may be adjusted for crushing stone from ¼ to 3 in. Weight, 4,300 lb. Furnished complete with power take-off, belt and engine governor ready for installation. Factory installations also available.—Eagle Crusher Co., Galion, Ohio.

DOVETAILED METAL SHEET which bonds plaster firmly to concrete ceilings, beams, columns or walls serves also as form for concrete, permitting use of skeleton falsework to support form. Dovetailed corrugations of sheet (shown in detail drawing) key plaster to ceiling; if painted sheet corrodes, rusting of metal only tightens joint. Sealed straight edges of abutting sheets match in center of 2-in. stringer and are tacked with brads to prevent underflow of concrete into plaster key. With Ke-Bond metal sheets at 7c. per square foot, records at Foxboro Hospital, Foxboro, Mass., show cost installed on floor forms of 70c. per square yard and saving on loose board forms of 20c. per square yard, leaving net estimated cost of Ke-Bond installed of 50c. per square yard. Plaster and labor costs on Ke-Bond on this job, calling for ¼-in. scratch coat and white darby coat averaging ⅛ in. thick, amounted to 30c. per square yard as compared with 80c. on metal lathe in same building. — Ke-Bond Co., 6 Beacon St., Boston, Mass.



A WHEELBARROW wheel receives hard use and this important part of a barrow must be built to take the bumps and still stay in service. Sterling wheels have 10-spokes 7/16" diameter counter-sunk in the tire and cast to the hub. Two self-lubricating bushings are pressed into each hub. Axle is 5/8" diameter cold rolled steel and fastened securely to malleable brackets by cotter pins.

TIRES on standard wheels are 3/8" x 1½". Tires of 2", 3" or 4" widths can be furnished if specified.

STERLING barrows can be equipped with wheels having a solid rubber molded tire 1¾" wide and 1⅝" thick, or with wheels having 16" x 4" pneumatic tires. Either 2-ply or 4-ply single tube construction tires can be furnished.

It Is Not a STERLING without the square "S"

S

BALANCED—*Sterling* WHEELS CARRY MORE THAN 80% OF THE LOAD

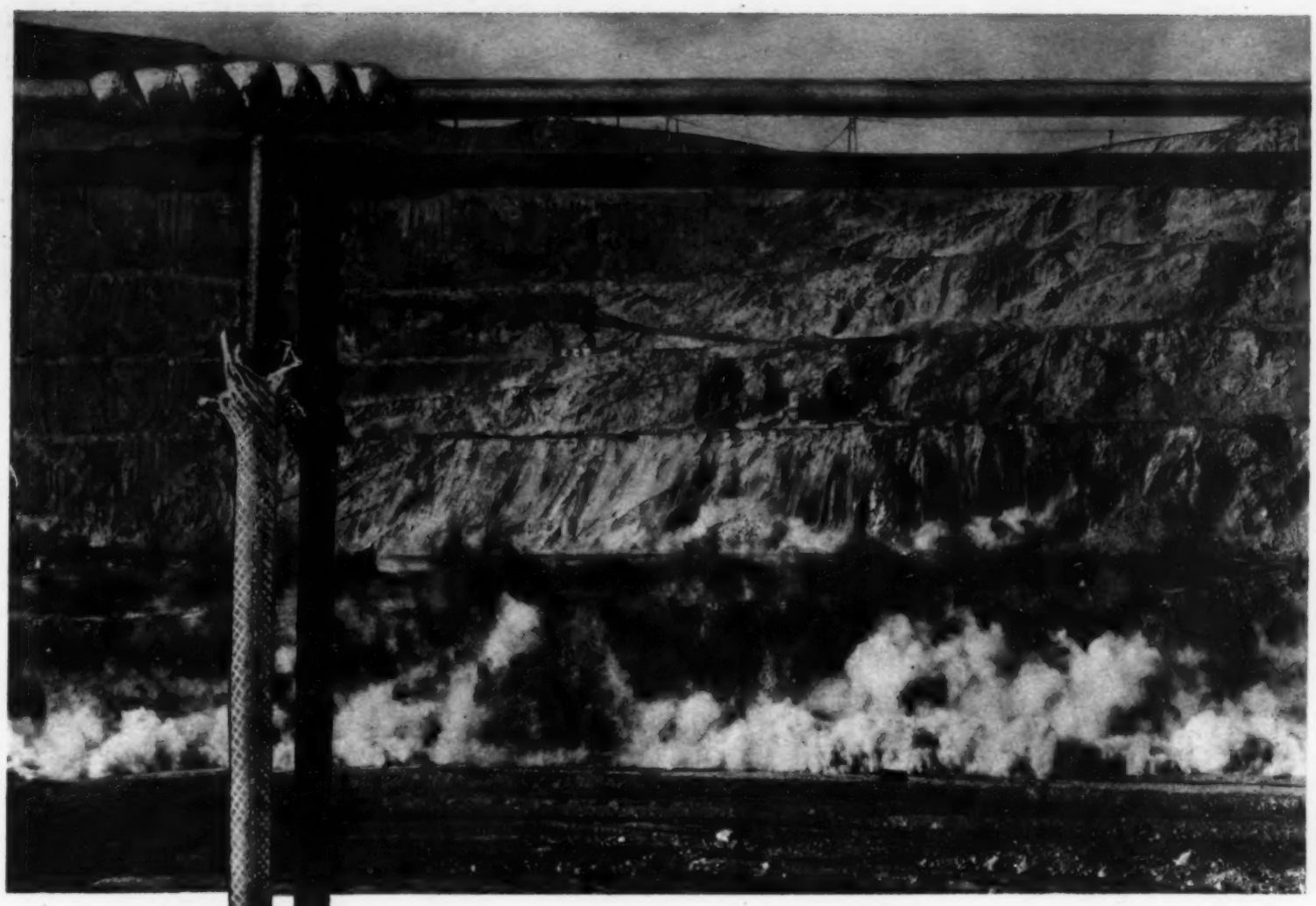
S

STERLING WHEELBARROW CO.

900 SOUTH 71ST STREET

MILWAUKEE • WISCONSIN, U.S.A.

S



Another CORDEAU *Shot*

at the

NEVADA CONSOLIDATED COPPER CORP.

"Go in and *dig!*"

You'll agree, it's a beautiful shot. But its real beauty lies well below the surface, where each charge is doing a job that will mean proper fragmentation, easier removal.

Beautiful shots don't "just happen." They are planned: (1) to get more work from explosives through direct detonation of each cartridge; (2) to fire the charges in split-second rotation that permits relief of burden, resulting in disintegration as well as displacement.

These are normal results when Cordeau-Bickford Detonating Fuse is used to detonate each charge and connect all holes. Simplified loading with less hazard are other features, equally important.

Let us send you, free, a copy of the Cordeau Book.

CB-53

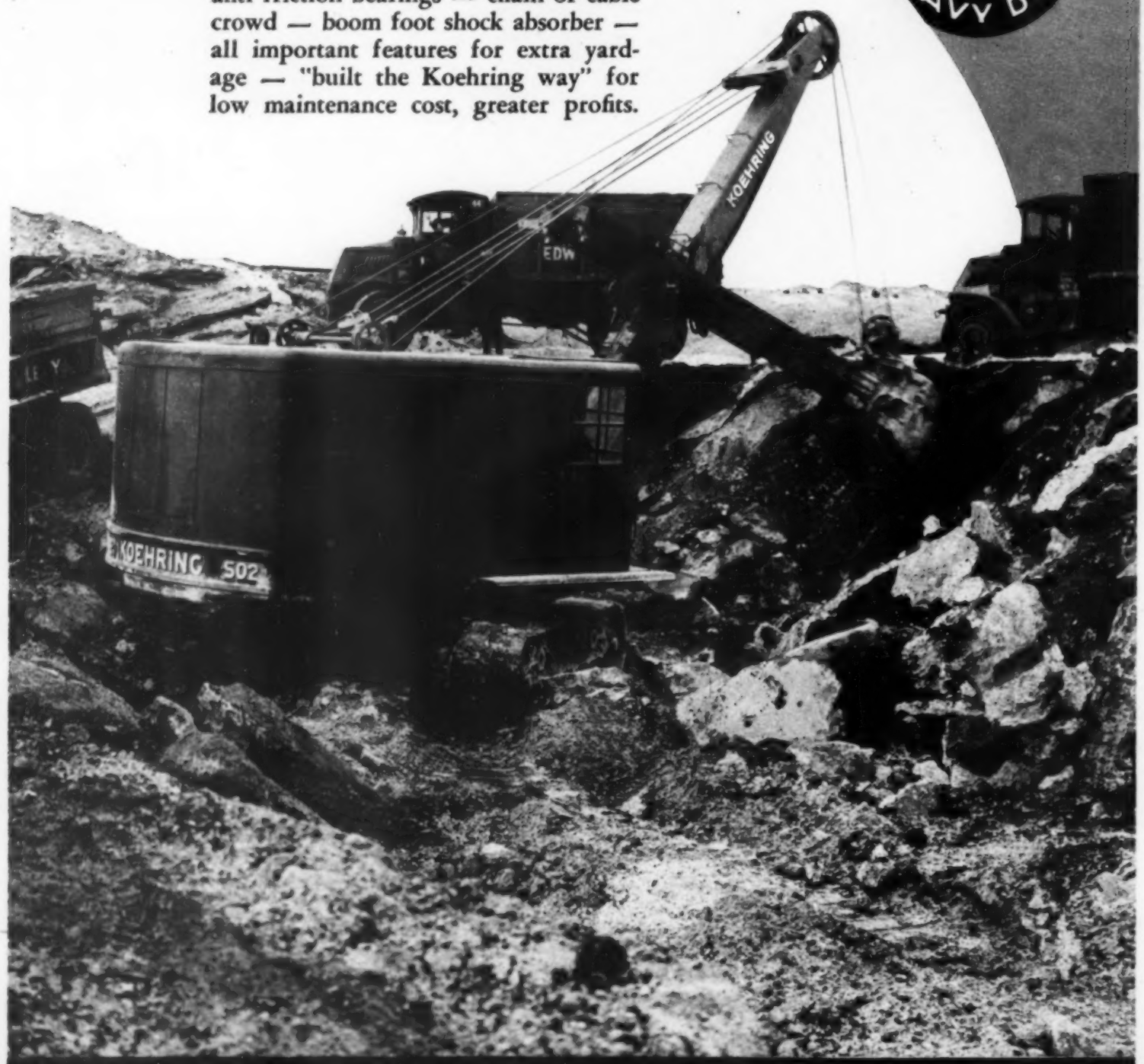
The ENSIGN-BICKFORD COMPANY, Simsbury, Connecticut
SAFETY FUSE Since 1836 • CORDEAU-BICKFORD DETONATING FUSE

KOEHRING

Extra Yardage

Koehring Extra Yardage Shovels—*two operating speeds,* controlled by a simple lever shift—power and speed for easy and hard digging — enclosed gears — anti friction bearings — chain or cable crowd — boom foot shock absorber — all important features for extra yardage — "built the Koehring way" for low maintenance cost, greater profits.

KOEHRING HEAVY DUTY



KOEHRING COMPANY

Pavers · Mixers · Shovels · Cranes · Draglines · Dumptors · Mud-Jacks

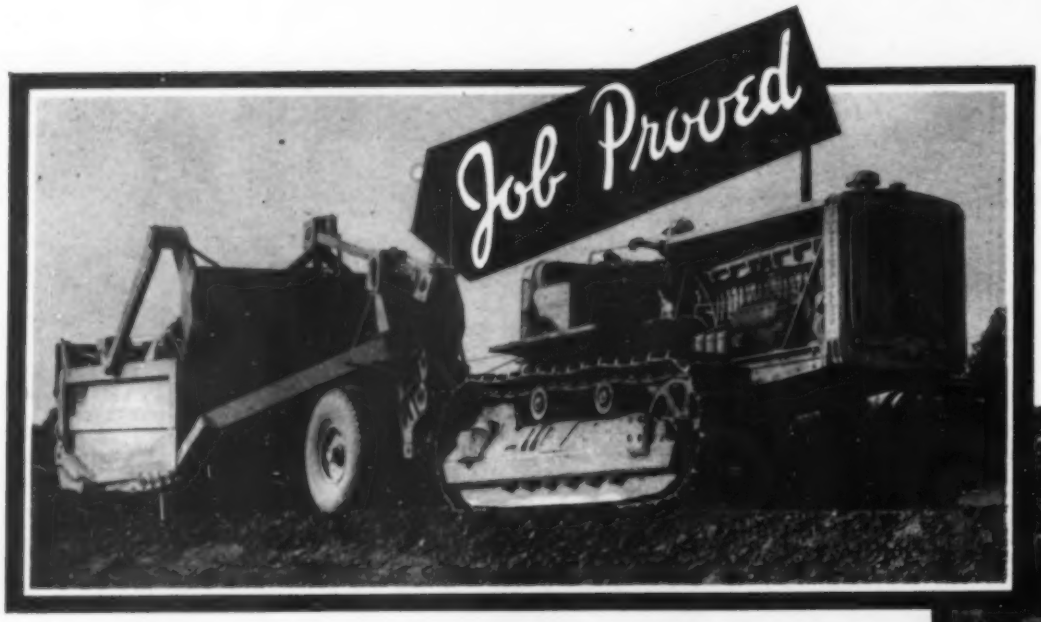
3026 WEST CONCORDIA AVENUE, MILWAUKEE, WISCONSIN

FIRST CHOICE
WHEN YOU CAN'T AFFORD DELAYS

Modern jobs demand modern hauling equipment—if you want maximum profits and minimum cost. And today, Athey Forged-Trak Bottom Dump Trailers offer the surest way to cut hauling time and expense. Easy to spot and able to handle bigger rounded loads, they match the pace of the big dippers. Lighter-running, self-cleaning Forged-Trak Wheels get them over bad ground when other hauling units "fold up." Stamina in every part keeps them on the job—and out of the repair shop. Used with "Caterpillar" Diesels, Athey Forged-Trak Bottom Dump Trailers give you everything that today's conditions demand. Replace NOW with Athey Forged-Trak Bottom Dump Trailers—you'll soon know why they are *first* choice for all-weather, heavy-duty hauling.

ATHEY TRUSS WHEEL CO.
5631 WEST 65th STREET, DEPT. J, CHICAGO, ILL. • CABLE ADDRESS: "TRUSSWHEEL" CHICAGO

ATHEY
Forged-Trak
REG. TRADE MARK



EXTRA PROFITS FROM CARRYALL VERSATILITY

On hundreds of construction jobs the country over, Le Tourneau Carryalls are cutting costs by moving dirt cheaper than is possible by any other method now available. To these low earthmoving costs, many an imaginative owner adds extra profits by using his Le Tourneau Carryall to handle incidental work that usually requires bringing in special equipment or the use of much hand labor, such work as stripping brush from borrow pits, finishing grades, bank sloping, backfilling, loading trucks from ramps, snow removal. A versatility born of correct, job-proved design, stout construction and powerful, trigger-quick cable control makes possible the handling of these extra jobs, makes possible the fast, economical movement of big yardages by Le Tourneau Carryalls.

Ask your Caterpillar tractor dealer to show you what Le Tourneau Carryalls can do on your job.

R.G. LE TOURNEAU INC

PEORIA, ILL. *Cable address:* "Bobletorno" **STOCKTON, CALIF.**

Manufacturers of: **ANGLEDOZERS, BUGGIES, BULLDOZERS, CARRYALL SCRAPERS, CRANES, DRAG SCRAPERS, POWER CONTROL UNITS, ROOTERS, SEMI-TRAILERS.**

Fractional-Inch Spreading — Positive tailgate unloading enables the Le Tourneau Carryall to spread in any desired lift from one inch to one foot. As a result of this spreading accuracy and the sureness with which the blade can be controlled, Le Tourneau Carryalls are frequently used for finishing work.

Backfilling to a Culvert — Because the wheels are mounted inside the cutting edge ends, Le Tourneau Carryalls can get in close to culverts, spread in thin lifts and so leave a compact backfill.

Bank Sloping — (below) Le Tourneau Carryalls, thanks to a low center of gravity, can work on slopes of 3 to 1, finish to almost any desired grade with little or no hand work.

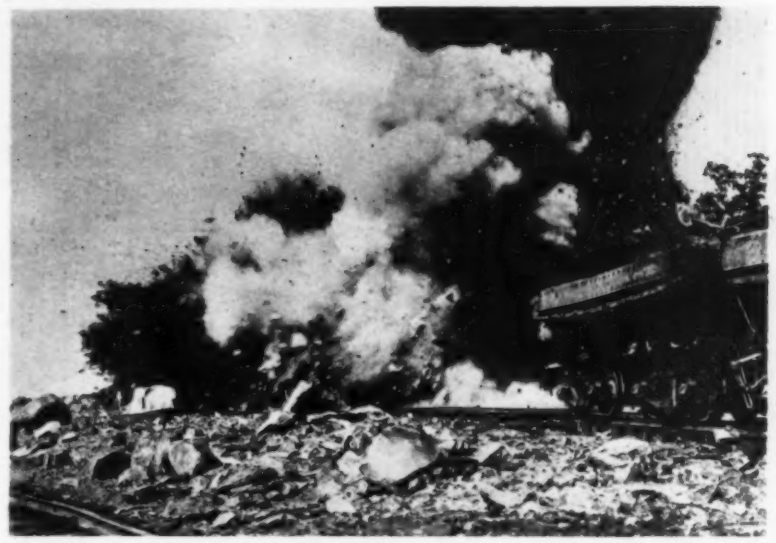
Snow Removal — This Carryall is clearing a city street of snow, enabling business to move on as usual. Many a contractor last winter used Carryalls to clear snow from borrow and gravel pits so work could go on profitably.

LE TOURNEAU *Job Proved* EQUIPMENT

GELODYN . . Economy

Just another photograph of BLASTING . .

But—



Back of every blast lies a story—a story that involves the strength of the dynamite and the velocity of detonation. It involves the ease of loading. It is concerned with water and moisture in bore holes. It climaxes in the cost per cubic yard of blasted material—and the cost per round of blasting.

It might well be entitled the "Economy of GELODYN"

Atlas Gelodyns combine features of advantage in many jobs. Among them are:

1. **More cartridges per case than higher priced gelatin types—thus permitting savings in cost.**
2. **Gelodyns' semi-gelatinous form gives better water resistance than ordinary explosives.**
3. **Gelodyns have adequate strength for favorable action.**
4. **Gelodyns' plastic form permits ease of loading in upward pitching bore holes.**

Under all but the most severe conditions, Gelodyns give many of the advantages of gelatin types with the economy of ordinary dynamites.

Ask the Atlas representative

ATLAS POWDER COMPANY, WILMINGTON, DEL.

Cable Address—Atpowco

Everything for Blasting

OFFICES

Allentown, Pa.	Joplin, Mo.	New Orleans, La.	Pittsburgh, Pa.	Spokane, Wash.
Boston, Mass.	Kansas City, Mo.	New York, N. Y.	Portland, Oregon	St. Louis, Mo.
Butte, Mont.	Knoxville, Tenn.	Philadelphia, Pa.	Salt Lake City, Utah	Tamaqua, Pa.
Denver, Colo.	Los Angeles, Calif.	Picher, Okla.	San Francisco, Calif.	Wilkes-Barre, Pa.
Houghton, Mich.	Memphis, Tenn.	Pittsburg, Kansas	Seattle, Wash.	

ATLAS

EXPLOSIVES

CHEMICALS ATLAS EXPLOSIVES

WARLIKE MANEUVERS OF ARMY TRUCKS PROVE VALUE OF NEW TIRE INVENTION

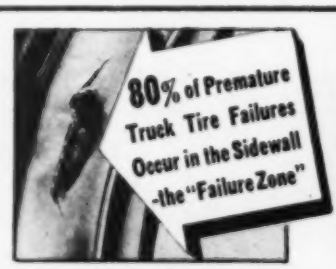
Thundering across open country, heavy army trucks and armored cars stop for nothing. They crash through underbrush, speed over highways, hurdle ditches if necessary .... Smack! A front tire takes a terrific impact as the car hits a curb-high bump. There's a screech as the driver yanks the wheel around a sharp curve. And the tires are twisted, dragged, tortured. Traveling over fields or highways, there's always the bruising, battering punishment of heavy loads on tire sidewalls. Every day is war for tires!

You'll find Goodrich Triple Protected Silvertowns on these big land battleships. You'll find the same tires on hundreds of the world's toughest trucking jobs. Because Silvertowns are *Triple Protected.*

Protects Against Blow-Outs

Every Goodrich Truck Tire has a new invention built into the sidewall—a 3-way check against blow-outs and breaks. This protection actually checks 80% of premature failures! No wonder operators everywhere choose Silvertowns for their toughest hauls—save money on any kind of haul.

Whether you carry one ton or twenty to a load, you can cut down on failures and delays, jump your mileage with Triple Protected Silvertowns. Don't spend another penny for tires until you see the local Goodrich dealer.



ONLY GOODRICH OFFERS THIS TRIPLE PROTECTION

1 PLYFLEX—distributes stresses throughout the tire—prevents ply separation—checks local weakness.

2 PLY-LOCK—protects the tire from breaks caused by short plies tearing loose above the bead.

3 100% FULL-FLOATING CORD—eliminates cross cords from *all* plies—reduces heat in the tire 12%.

© 1936, The B. F. Goodrich Co., Akron, Ohio.

Goodrich *Triple Protected* **Silvertowns**

SPECIFY THESE NEW SILVERTOWN TIRES FOR TRUCKS AND BUSES

NICKEL CAST IRON

helps the BIGGEST DREDGE *dig for the* BIGGEST BRIDGE

● Large or small, the dredge pump has to stand biting abrasion and wear. Imagine the scrape and grind on the innards of the pump casing below. It sucks up sharp sand, gravel and clay, whirls it around at 355 R. P. M., then forces it out with pressure enough to carry 4 miles when need be! Nickel Cast Iron has the toughness and wear-resistance to stand firm under this abrasion. Its dense structure is pressure-tight. And it is readily machinable.

Inco engineers have had wide experience, and are glad to share it. Ask them to recommend compositions of Nickel Alloys to suit your needs.

● The San Francisco-Oakland Bay Bridge, the world's longest. Several thousand tons of Nickel Alloy Steel went into its construction.

● This dredge pump casing on the "Marshall C. Harris," made by The Golden State and Miners Iron Works, of San Francisco, weighs 25,000 pounds. The pump digs an average of 900 cubic yards per hour. To enable it to handle these masses of sharp abrasive, the casing is made of a Nickel-Chromium Cast Iron containing 1.50-2.00% Nickel and about 0.50% chromium.

• • •

● (*Left*) The dredge "Marshall C. Harris", probably the largest suction dredge of its type in the world and one of the most powerful.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 WALL STREET, NEW YORK, N. Y.

CONTRACTORS are proving IT'S A GREAT VALUE!

In your industry, in other industries—in communities throughout the country—profit-minded business men are putting GMC trucks to work. And then they are quickly confirming their good judgment by proving conclusively the downright value of a GMC.

Whatever the hauling demands of your business may be, there's a GMC to fit—and fit exactly. Take for instance the GMC 3-ton truck that is priced at only $895, chassis f.o.b. Pontiac. It has a larger engine than ever before in a GMC at this low price. It has an efficient valve-in-head engine and many, many modern mechanical refinements that assure utmost economy, performance and reliability. There is, likewise, advanced streamlined styling which sets it apart as a truly distinctive vehicle. And available for this 3-ton GMC is the all-steel "helmet top" cab—a rugged, roomy, comfortable and weatherproof driver's compartment if there ever was one.

Get the facts through seeing and comparing this great 3-ton value. Or if your needs call for a smaller or larger truck, there is a quality General Motors Truck with value equally as great.

GMC
THE TRUCK OF VALUE
½ TO 15 TONS

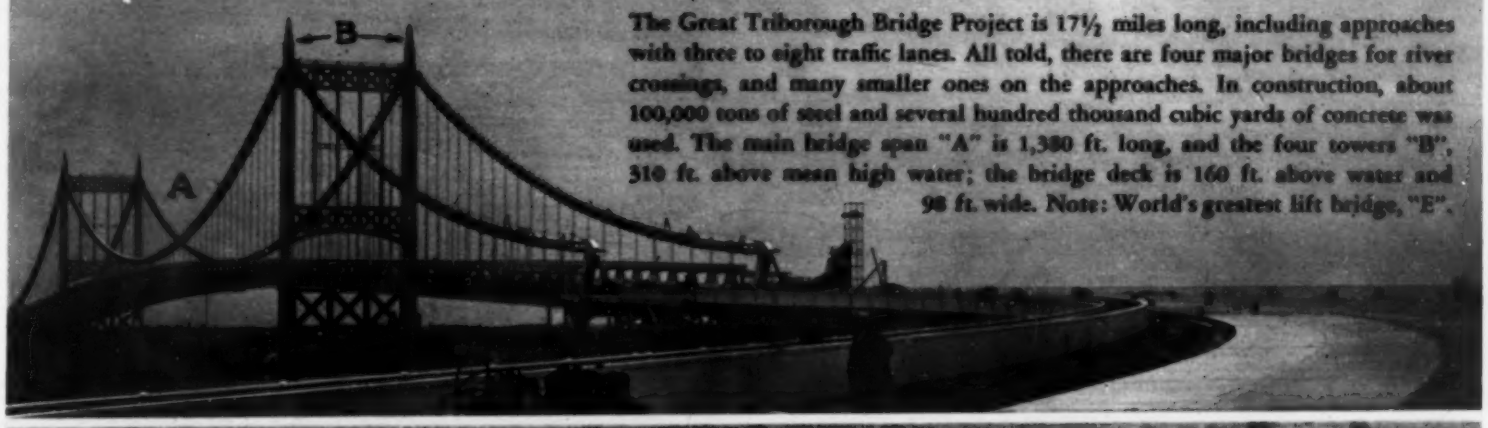
Time payments available through our own Y. M. A. C. 6% plan

General Motors Trucks and Trailers

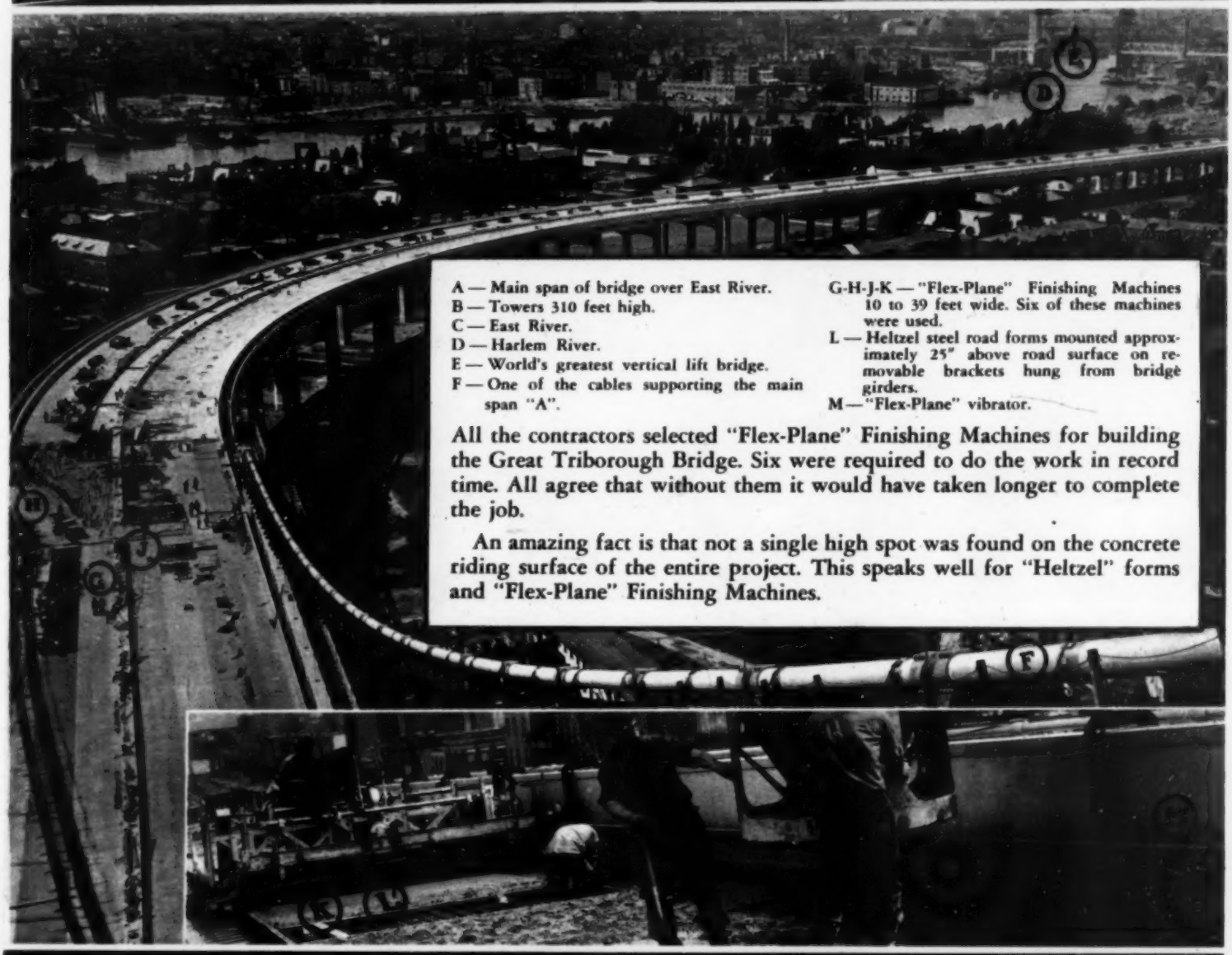
GENERAL MOTORS TRUCK COMPANY. PONTIAC. MICHIGAN

FLEX-PLANE FINISHING MACHINES

Score Another Triumph



The Great Triborough Bridge Project is 17½ miles long, including approaches with three to eight traffic lanes. All told, there are four major bridges for river crossings, and many smaller ones on the approaches. In construction, about 100,000 tons of steel and several hundred thousand cubic yards of concrete was used. The main bridge span "A" is 1,380 ft. long, and the four towers "B", 310 ft. above mean high water; the bridge deck is 160 ft. above water and 98 ft. wide. Note: World's greatest lift bridge, "E".



A — Main span of bridge over East River.
B — Towers 310 feet high.
C — East River.
D — Harlem River.
E — World's greatest vertical lift bridge.
F — One of the cables supporting the main span "A".
G-H-J-K — "Flex-Plane" Finishing Machines 10 to 39 feet wide. Six of these machines were used.
L — Heltzel steel road forms mounted approximately 25" above road surface on removable brackets hung from bridge girders.
M — "Flex-Plane" vibrator.

All the contractors selected "Flex-Plane" Finishing Machines for building the Great Triborough Bridge. Six were required to do the work in record time. All agree that without them it would have taken longer to complete the job.

An amazing fact is that not a single high spot was found on the concrete riding surface of the entire project. This speaks well for "Heltzel" forms and "Flex-Plane" Finishing Machines.

FLEXIBLE ROAD JOINT MACHINE COMPANY

WARREN, OHIO

BETHLEHEM *Steel Sheet* PILING

used in rejuvenation of—

Boston Army Base Pier

WHEN repairs to the sub-structure of the Army Base Pier at Boston became necessary, it was decided to surround the platform structure with a wall of steel sheet piling and fill with sand and gravel up to the high-tide level. T. Stuart & Son Co., Newton, Mass., were the general contractors.

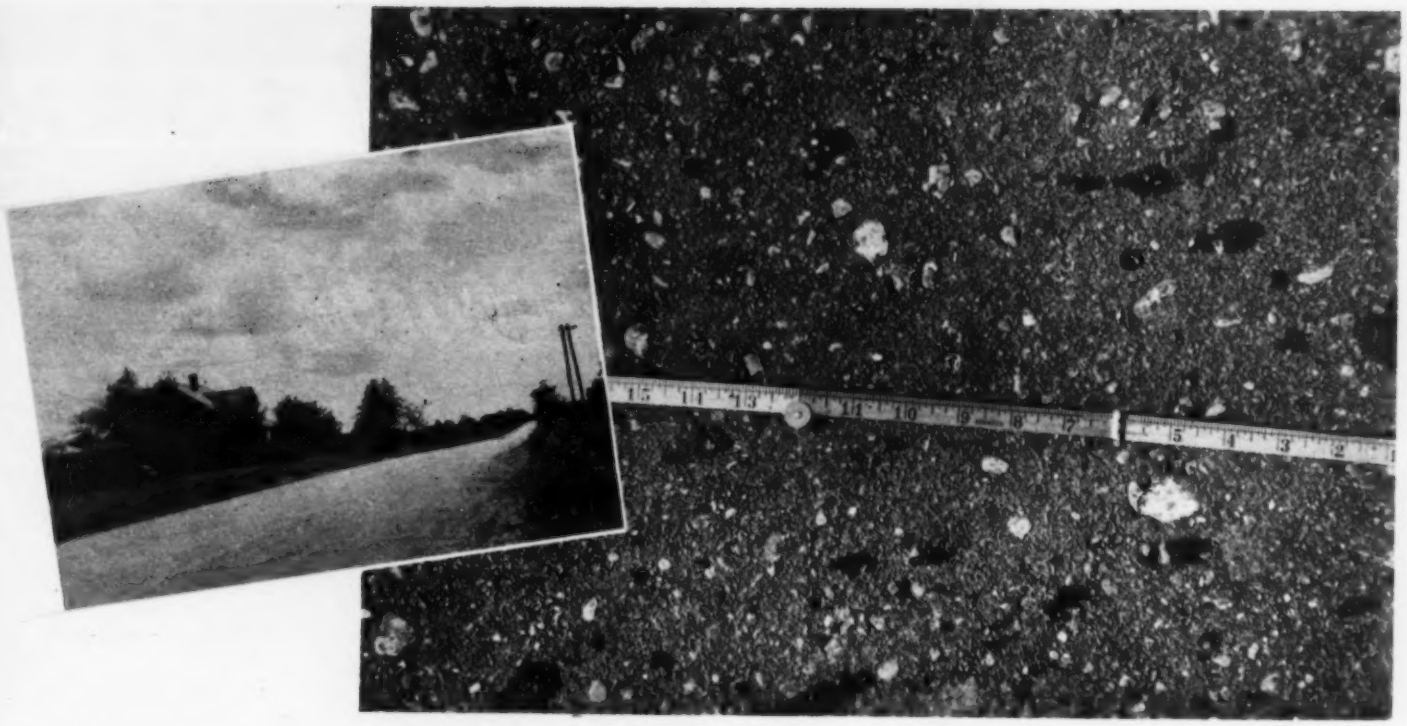
In carrying out the repairs, a wall of Bethlehem Steel Sheet Piling, approximately 5600 feet long, was driven along two sides and one end of the pier and tied to the platform structure. This wall of steel efficiently confines the fill and is immune to the attacks of marine borers which are becoming increasingly active in New England waters.

Many similar reconstruction projects have been economically carried out with Bethlehem Steel Sheet Piling. Bethlehem Steel Sheet Piling is also extensively used to form the original bulkhead walls for new construction of wharves and piers and in the construction of cofferdams, permanent cut-off walls and in sea wall projects of many kinds.

BETHLEHEM STEEL COMPANY, *General Offices:* Bethlehem, Pa. *District Offices:* Albany, Atlanta, Baltimore, Boston, Bridgeport, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Hartford, Honolulu, Houston, Indianapolis, Kansas City, Los Angeles, Milwaukee, New York, Philadelphia, Pittsburgh, Portland, Ore., Salt Lake City, San Antonio, San Francisco, St. Louis, St. Paul, Seattle, Syracuse, Washington, Wilkes-Barre, York. *Export Distributor:* Bethlehem Steel Export Corporation, New York.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY



This may be the answer to your highway problem

This Ingham County, Mich., road is the answer to the problem facing many road builders. Where smooth, lasting, but economical surfaces are needed, the type Ingham County has used extensively may well be the answer.

Locally available, dense graded gravel was mixed thoroughly right on the old road with the proper grade of TEXACO Slow-curing Cutback Asphalt, producing a 2-1/2 inch compacted wearing surface.

The tough, skid-proof and low cost qualities of this TEXACO Asphaltic surface strongly recommend it, particularly to the road builder with a limited budget.

Why not discuss this with a TEXACO field man?

TEXACO
REG. T. M.

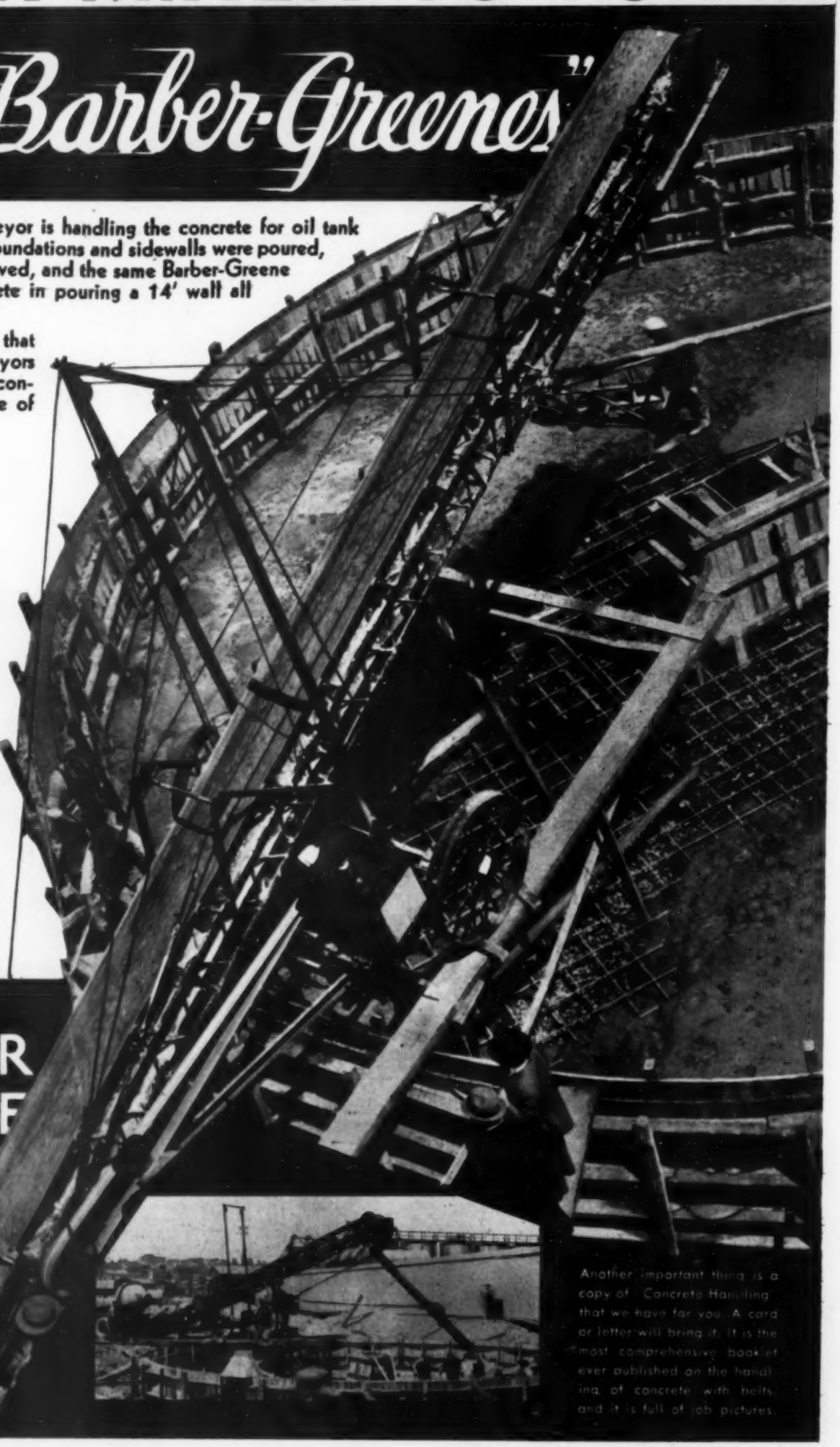
THE TEXAS COMPANY, Asphalt Sales Dept.
135 East 42nd St., New York City

Buffalo Philadelphia Richmond Boston Jacksonville
Chicago Cleveland Kansas City, Mo. Houston Dallas

TEXACO ASPHALT

TRUCK MIXER TO FORMS

"Via Barber-Greenes"



This Barber-Greene Conveyor is handling the concrete for oil tank foundations. After ten foundations and sidewalls were poured, the swivel spout was removed, and the same Barber-Greene elevated all of the concrete in pouring a 14' wall all around the property.

But the important thing is that Barber-Greene Belt Conveyors are used for handling concrete in almost *every* phase of construction, including:

PIERS
DAMS
LOCKS
WALKS
SEWERS
BRIDGES
TUNNELS
VIADUCTS
STADIUMS
BUILDINGS
PAVEMENTS
ELEVATIONS
RETAINING WALLS
IRRIGATION DITCHES

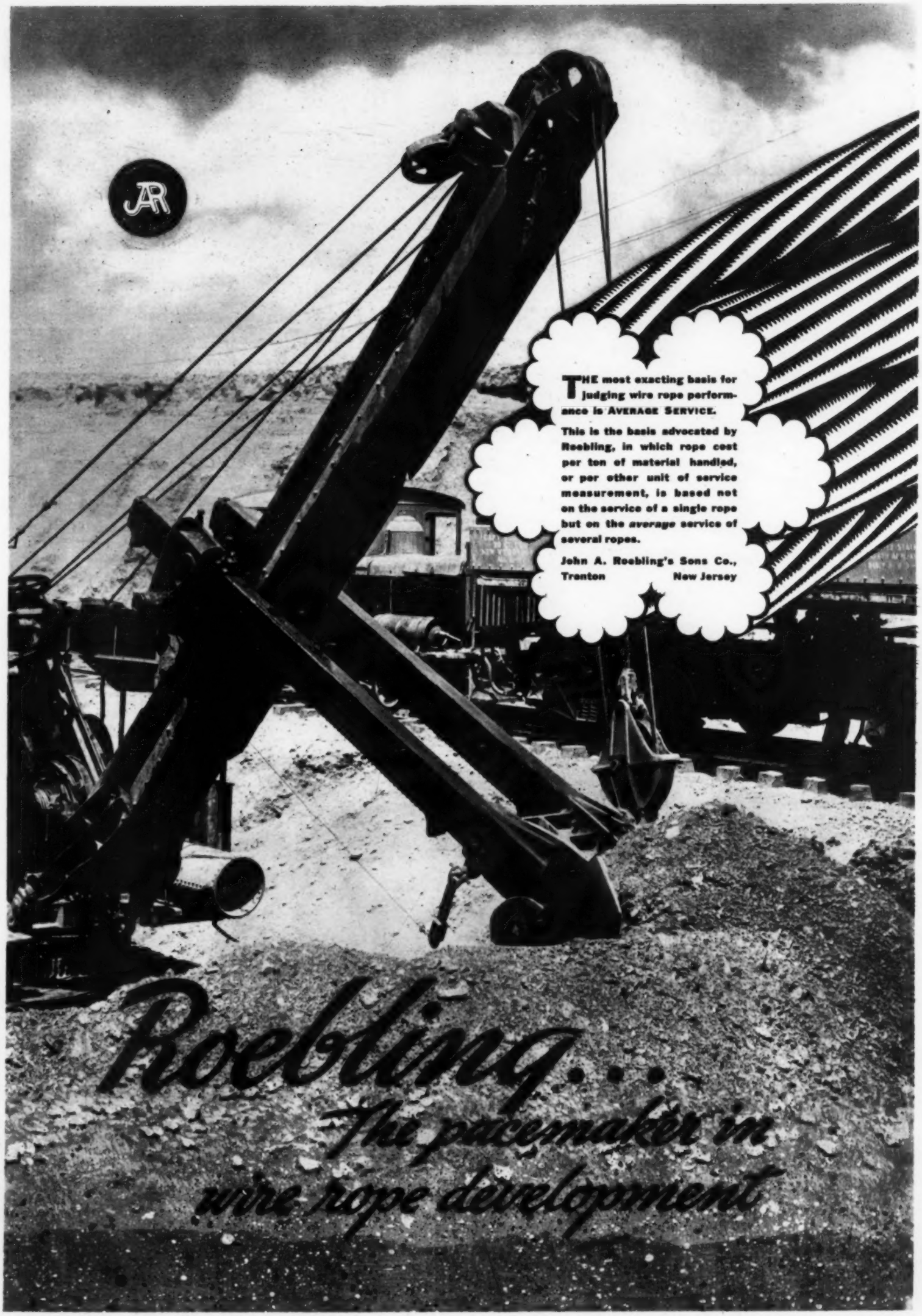
We maintain a department for the sole purpose of aiding in laying out concrete handling jobs. Write us about your next job.

BARBER-GREENE COMPANY
530 West Park Avenue
Aurora, Illinois

35-7

BARBER GREENE

Another important thing is a copy of Concrete Handling that we have for you. A card or letter will bring it. It is the most comprehensive booklet ever published on the handling of concrete with belts, and it is full of job pictures.


JAR
THE most exacting basis for judging wire rope performance is AVERAGE SERVICE.
This is the basis advocated by Roebling, in which rope cost per ton of material handled, or per other unit of service measurement, is based not on the service of a single rope but on the *average* service of several ropes.
John A. Roebling's Sons Co., Trenton New Jersey
Roebling...
The pacemaker in wire rope development

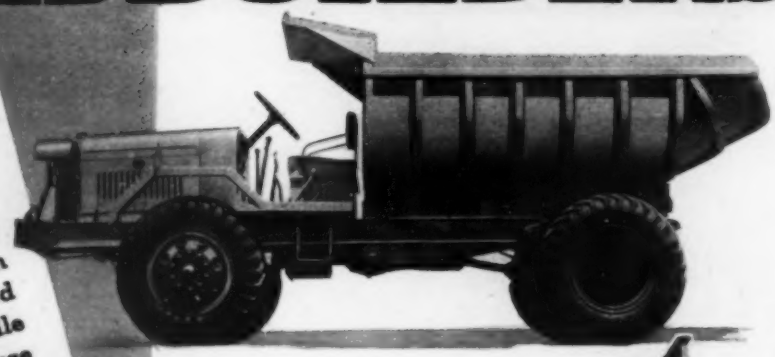
HUG ROADBUILDERS

ARE BUILT TO *Pay Dividends* TO YOU!

● Profits and dividends depend upon completing your contracts on time—this means that your transportation equipment must be absolutely reliable. You can't afford breakdowns while the shovel is operating or delays while the mixer is busy. That's why so many contractors use Hug Roadbuilders exclusively and *insure their profits.* They know that Hugs get on the job early and stay late, taking the loads out fast, under any conditions until the job is finished. Season after season, year after year, Hugs keep going—profitably!

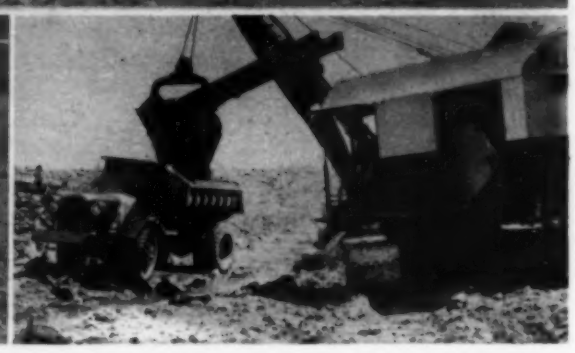
Proven in exhaustive competitive tests, the low cost of operation, ability to get in and out of unusual places, speed, ease of operation and the sturdy construction of these Hug Roadbuilders have induced contractors and roadbuilders everywhere to use Hug equipment on their jobs. The ever-growing number of Hug fleets on the toughest jobs in the country is the plainest and most effective evidence of their superiority.

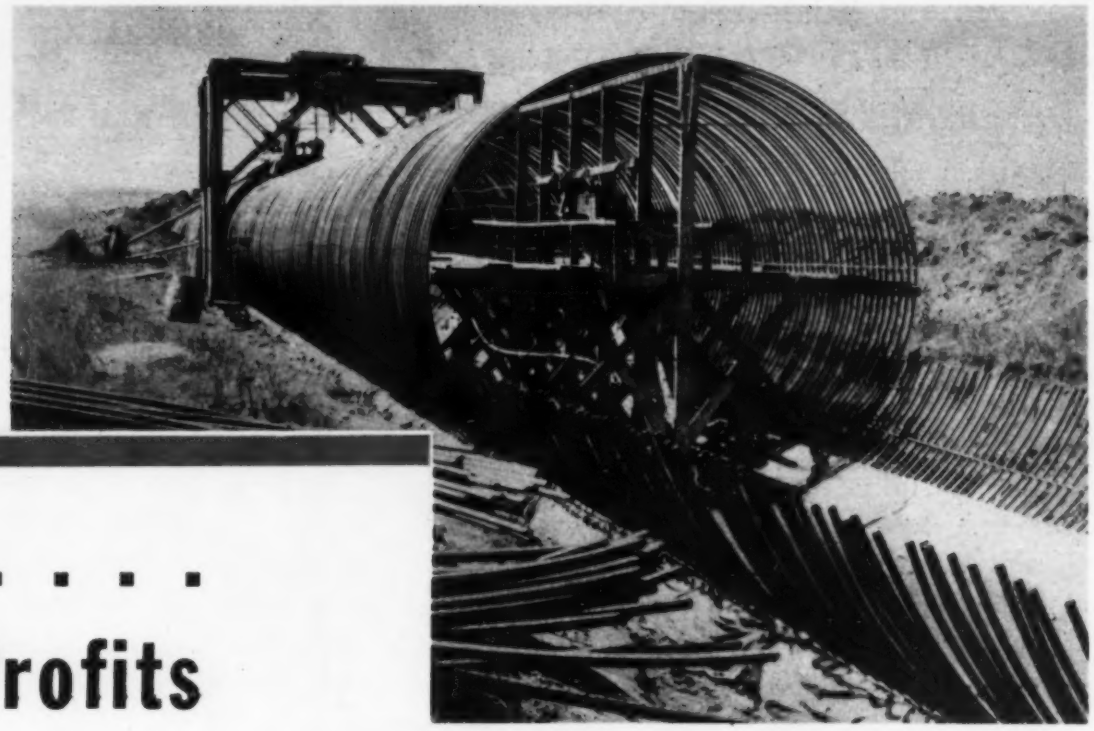
THE HUG COMPANY
503 Cypress Street HIGHLAND, ILLINOIS



● *Model 87Q Hug Roadbuilder with 6-yard Hug scoop end body and direct reversible, double acting high angle hoist.*

● *One of a fleet of 28 Model 87Q Hug Roadbuilders operated by Hallet Construction Company, Crosby, Minnesota, and used on dirt moving operations. Thirteen of these Hugs equipped with the Hug scoop end body are in use at Fort Sumner, New Mexico, and fifteen at Golden, Colorado.*





J & L Diamond Bars for Concrete Reinforcement

J & L Diamond Bars were used exclusively in the construction of the pressure syphon, illustrated here, in the Southerland Project, at Paxton, Nebraska, because of their dependable strength and unusual bending qualities. This pressure syphon is the largest of its kind ever constructed. Inside diameter is 14 feet and the water head 44 feet.

Cut Costs . . . . Increase Profits with J & L Steel Products

You profit when you specify and use J & L steel construction products, because their uniform high quality and their close conformity to specifications enable you to shorten construction time and cut your costs.

Then, too, the wide variety of J & L steel products gives you the further time- and money-saving advantage of being able to concentrate your purchases with one single reliable organization.

Engineers and contractors know from many years of experience that they can always depend on J & L steel products for uniform high quality and for long trouble-free service.

Specify J & L steel products. You, too, will find that they give you dependable performance, shorten construction time, and cut your costs.

JONES & LAUGHLIN STEEL CORPORATION

AMERICAN IRON AND STEEL WORKS

JONES & LAUGHLIN BUILDING, PITTSBURGH, PENNSYLVANIA

Sales Offices: Atlanta Boston Buffalo Chicago Cincinnati Cleveland Dallas Denver Detroit Erie Houston Los Angeles Memphis Milwaukee Minneapolis New Orleans New York Philadelphia Pittsburgh Seattle St. Louis San Francisco Tulsa

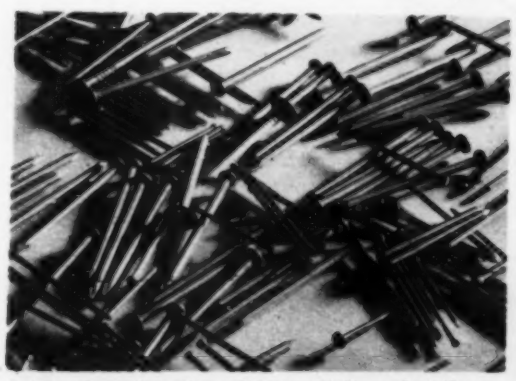
Warehouses: CHICAGO CINCINNATI DETROIT MEMPHIS NEW ORLEANS NEW YORK (Long Island City)* PITTSBURGH

*Operated by National Bridge Works Division of Jones & Laughlin Steel Service, Inc.

Canadian Representatives: JONES & LAUGHLIN STEEL PRODUCTS COMPANY, Pittsburgh, Pa., U. S. A., and Toronto, Ont., Canada

Economical Erection with J & L Fabricated Structural Work

Shown above is a portion of the extensive grade elimination project of the Long Island Railroad Company, at Valley Stream, Long Island City, N. Y.—an outstanding example of Jones & Laughlin fabricated structural work. Economical erection and maximum serviceability are features of J & L fabricated structural work.



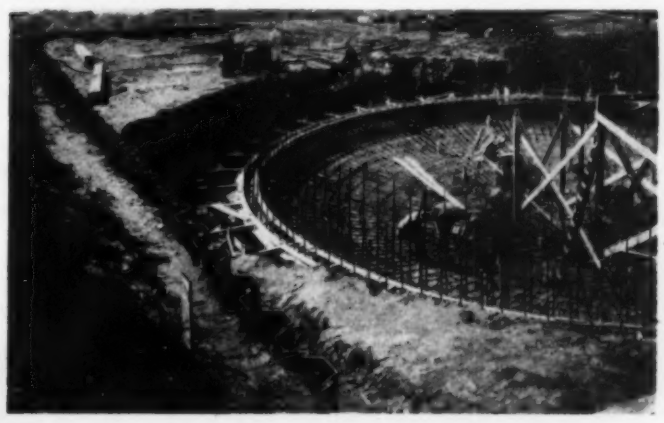
The Complete Line of J & L Nails and Spikes Will Meet Your Every Need

J & L nails and spikes are made of carefully selected wire in a wide range of types and sizes. They are accurate as to length and gauge, with clean surfaces, uniform heads and well-cut points.

Look to J & L for All Your Steel Requirements

Piling . . . Plates . . . Structural Shapes, including Junior Beams and Lightweight Channels . . . Bars for Concrete Reinforcement . . . Assembled Road Bar Mats . . . Tie Wire . . . Steel Pipe . . . Fabricated Structural Work, including Steel Plate Construction . . . Nails and Spikes.

J&L STEEL



Strength, Economy and Durability with J & L Steel Piling

Illustrated here is a J & L steel piling cofferdam at the Westerly Sewage Treatment Works, Cleveland, Ohio, showing construction of sludge digestion tanks. The trouble-free performance of J & L Steel Piling is assured by its straightness and proper interlock clearance.

TWO WRENCHES IN ONE

Each head turns two different sized nuts

THE

"FAVORITE" Reversible Ratchet WRENCH

Is Just The Tool For Contractors

on the nut-turning portion of the contract that must be speeded up

CADMIUM FINISH

BUILT OF A STRONG, TOUGH METAL

Works on a quick straight-ahead ratchet movement, and the socket form of head is not removed from the nut until operation is completed.

Can be used in narrower places than an ordinary wrench.

A TIME-SAVER

The design of the "Favorite" wrench is simplicity itself, having no complicated parts necessitating expensive machine work.

It is an efficient time-saving tool at a proper price.

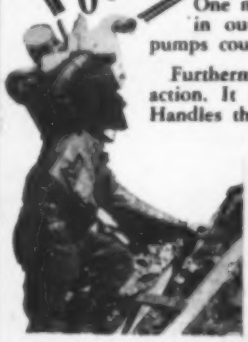
Write for full particulars

GREENE, TWEED & CO.,
109 Duane St. New York
Sole Manufacturers

Make a HOMELITE *the Boss over Water*

A Homelite 3-inch centrifugal pump gives you action. It weighs only 93 pounds complete with built-in gasoline engine, yet it pumps 15,000 gallons per hour. One man can carry it and set it up anywhere — in out of the way places — places that larger pumps couldn't reach.

Furthermore the Homelite gives you *dependable* action. It is completely automatic and self-priming. Handles thick muddy water or seepage and has a 28 foot suction lift.



Built like your huskiest worker, these Homelite pumps are made to go on the job and stay on the job. They start instantly — need no manual attention — stand up under the toughest working conditions. Thousands are in use.

SEND FOR BULLETIN

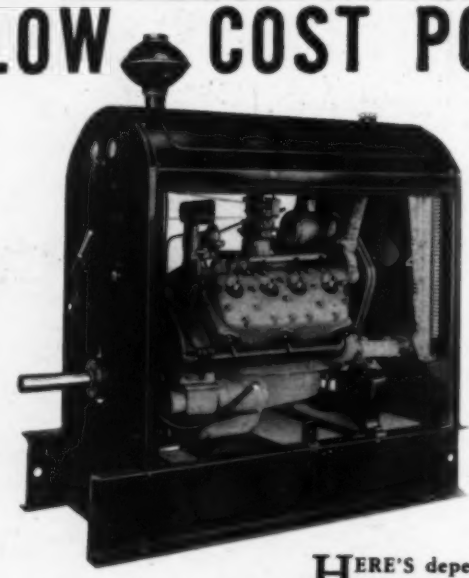
HOMELITE CORPORATION

609 RIVERDALE AVENUE, PORT CHESTER, N. Y.

LOW COST POWER

with this

KRW FORD V-8 UNIT



HERE'S dependable, low-cost power up to 60 H. P. — complete, compact, portable. Ideal for welders, compressors, hoists, pumps, well drilling outfits and other contractors' equipment.

Assembled with brand new heavy duty Ford V-8 Truck engine. Large capacity radiator protected by heavy screen. Engine rubber mounted — outfit complete with governor gas tank, 17 plate battery, instruments and louvered side panels to thoroughly enclose the engine.

WRITE for complete information, price, and data showing how this unit will *pay for itself out of savings* in a few weeks, whether operated on gasoline or natural gas. You can buy thru your Ford Dealer and benefit by local service and low-cost Ford engine replacement feature.

***Also* K R W ELECTRIC PLANTS**

20 KW outfit with dual voltage take-off for handling *both* light and power requirements simultaneously.

K. R. WILSON 15 Lock St. BUFFALO, N.Y.

EXCLUSIVE BUILDER OF APPROVED FORD SHOP EQUIPMENT SINCE 1918

P&H MODEL 355

●How many different sizes and kinds of jobs should a ¾-yd. shovel handle profitably? What is a fair cost per yard? . . . per working hour? . . . per mile of travel? How much is lost in idle time? How much in repair bills each year? Men who are shovel-wise know these costs! That's why they recognize the new Model 355 as a bigger money-maker. They can handle more jobs; move quicker from place to place, work faster, keep busier —earn more. If you want to see what all-welded construction with alloy steels has done for this new ¾-yd. machine compare your present costs, yard for yard, dollar for dollar of investment with the pacemaking production the Model 355 gives you. Write for complete details.

"Here's universally approved design — tractor-type crawlers for dependable travel at lowest cost. Resiliency in the track itself protects alloy steel shoes against breakage."

Bulletin X-10 describes the Model 355. Ask for your copy. A post card will bring it.

HARNISCHFEGER CORPORATION

4494 W. NATIONAL AVE. *Established in 1884* MILWAUKEE, WIS.

Warehouses and Service Stations:

Hoboken — Memphis — Seattle — Jacksonville — Dallas — Los Angeles — San Francisco

P&H PACEMAKERS - FASTER ON THE JOB

50% MORE DIRT MOVED with a PAGE AUTOMATIC

Users Report On Yardage Increases

Read What They Say:

A Contractor Writes:

*"It comes nearest to doing the work of a shovel bucket in rock, with all the advantages of the dragline that I believe possible."

From A Gravel Plant Owner:

*"Has increased our production at least 75%. To us the Page AUTOMATIC is the ONLY bucket for dragline work."

A Strip Mine Operator Says:

*"Can truthfully say that since putting on your AUTOMATIC we are stripping at least 50% more material."

*From letters in our files.

You also can increase your yardage and dragline profits! For information on a size and weight AUTOMATIC bucket for your machine and job—see your equipment dealer or write us direct. Free bulletin "The AUTOMATIC" gladly sent on request.

". . . Dig with a PAGE AUTOMATIC"

Address Dept. S

BUILT IN SIZES 3/8 TO 15 CUBIC YARDS

PAGE ENGINEERING COMPANY

CLEARING POST OFFICE CHICAGO, ILLINOIS

COFFING ADVANCED DESIGN HOISTS

Skidding a 50 ton Diesel into position with a hoist weighing only 25 lbs.

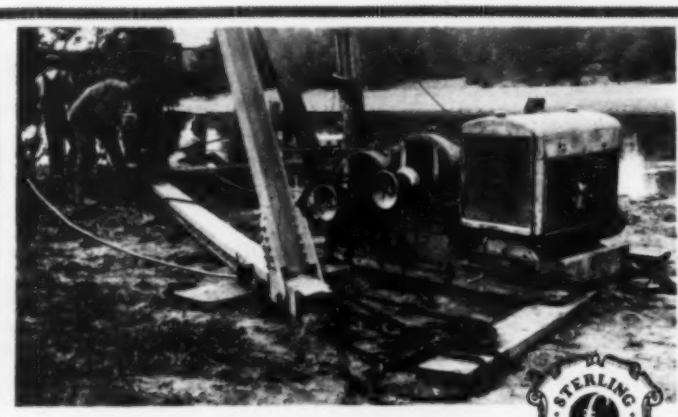
A wonderful time and labor saver on your job

● This is only one example of hundreds! — These one-man ratchet hoists will lift or pull almost anything on your job — heavy, pipe, cable, machinery. All parts precision built — finest materials and each unit tested to 100% over rated capacity! Long-lived—low in maintenance—you can't wear them out. Capacities from ¾ to 8 tons — weight 14 to 65 lbs. Send for Catalog.

COFFING HOIST CO.

COFFING HOIST COMPANY

DANVILLE ILLINOIS



The above illustration shows a Sterling type A Hoist sold by C. F. Rabbeitt, Inc. being used for pile driving near St. Louis.

STERLING QUALITY

NEW STERLING HOIST CATALOG

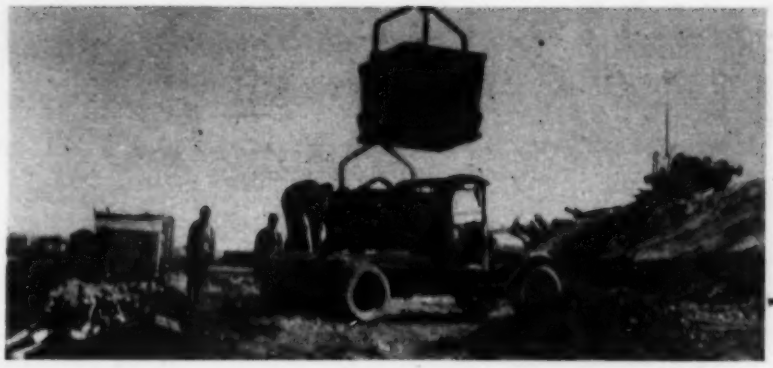
Just off the press—a combination catalog and hand book of engineering data of great value to every engineer, contractor, or anyone interested in hoist problems.

Regardless of your requirements, there is a Sterling Hoist for every job. Our Engineering Department will gladly offer helpful suggestions without any obligation to you whatever. Write for Catalog.

Sterling

MACHINERY CORPORATION

413-13 Southwest Blvd. Kansas City, Mo.



GENERALS HELP MAKE MISSISSIPPI NAVIGABLE

Spencer, White and Prentis, Inc. of New York City, are constructing a nine-foot channel for the U. S. Government, on the Mississippi River in Northern Minnesota, to make it commercially navigable. A large fleet of tractor-trucks are being used in the work and all are equipped with General Traction-tread Tires, because of their superiority in providing traction over rough, soft going. Photo by courtesy of W. L. Schultz, of the War Dept., U. S. Engineers Corp.

25 YARDS OF BULK CONCRETE!

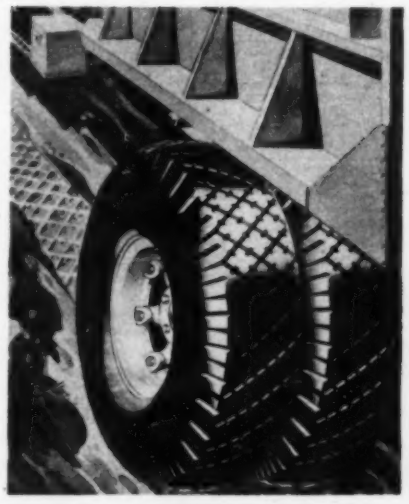
This truck carries the largest Diesel engine made for trucks—and the body holds 25 yards of bulk concrete. Triangle Rock and Gravel Company are using it in the construction of new water supplies for the City of Los Angeles. The construction job will use almost twice as much concrete as Boulder Dam. Triangle can't afford to have this job held up with tire trouble, so they put on 18 Generals.

THEY GIVE THE TOUGH JOBS to Generals··everywhere

FIND A JOB that's hard on tires—and you'll usually find Generals. That's because Generals have proved that they can "take it" where other tires fail.

If *your* job is tough there is a General Tire that will do it better at lower cost. Dependable Generals are proving this statement to skeptical "show me" operators every day.

Your General Tire dealer has a complete, highly specialized line of truck tires. He is a practical truck tire man with wide experience and accurate knowledge in fitting the right type and size of tire to every kind of job. This combination is worth real money to you. Call him in.



THE GENERAL HEAVY DUTY TRACTION BALLOON is made to order for the toughest construction jobs. It is only one of the complete line of Generals—each designed and built specifically to do a certain job better.

3 Reasons Why Generals Are More Profitable to You:

1. Generals are stronger tires—additional full-width plies of powerful cord are anchored bead to bead—with no "idle" plies—no floating breaker-strips.
2. Generals are cooler tires—they flex uniformly without that heat-producing "hinging action" of ordinary breaker-strip tires.
3. Generals have "compact rubber" treads—their construction keeps the tread rubber compact and compressed so that it wears slowly and gives more miles.

FREE

Read this booklet on how to avoid the more expensive tire troubles. Write to The General Tire and Rubber Company, Akron, Ohio. In Canada—The General Tire and Rubber Company of Canada, Limited, Toronto, Ont.

GENERAL TRUCK TIRES

The INSLEY *Type* "K"

⅜ YD. FULL REVOLVING EXCAVATOR

SAVES TIME and PROFIT

Interchangeable Attachments as Shovel, Trench-Hoe, Dragline, Clamshell, Crane — Crawler and Truck Mounted

BUILT by the PIONEERS in the SMALL SHOVEL FIELD

CATALOG No. 112 will explain fully —
May we send you a copy?

INSLEY MFG. CORP. OLNEY & E. ST. CLAIR INDIANAPOLIS, IND.

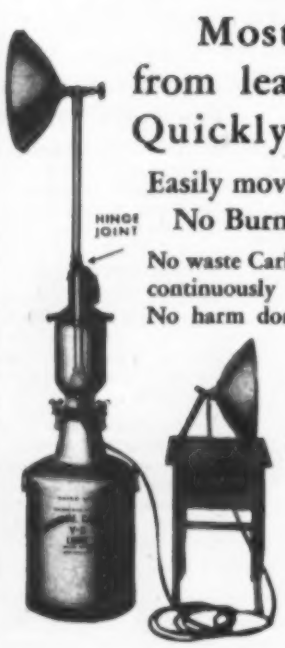
Shovels, Trench Hoe Excavators, Draglines, Clamshells, Cranes, Derricks, Wagons, Shoulder Finishers, Cars, Buckets, Hoppers, Carts, Concrete Placing Equipment

NATIONAL CARBIDE

V-G LIGHTS

Most Light
from least Carbide
Quickly Charged

Easily moved—No wires
No Burner Troubles



No waste Carbide whether used continuously or intermittently
No harm done if tipped over

Extension to X-100 DOUBLES THE CANDLE POWER *fastens anywhere*

Always use NATIONAL CARBIDE *"In the Red Drum"* Distributors Coast to Coast

WRITE FOR COMPLETE INFORMATION

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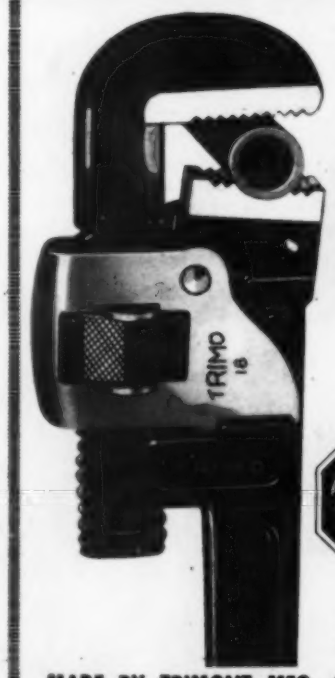
NATIONAL CARBIDE V-G LIGHT
About 8,000 c.p. for 12 hours on 7 lb. charge of National Carbide. Easily handled by one man. Weight 35 lbs. empty; 98 lbs. full.

Y199
NATIONAL CARBIDE V-G HANDY LIGHT
Burns about 5½ hours on 1¼ lbs. of 14-ND Carbide, 2 gals. water; delivers about 1500 c.p. Weighs 37 lbs. charged—easy to carry, handy in emergencies.

WL1-C1
NATIONAL CARBIDE LANTERN
Burns 8 hrs. on 8 oz. of Carbide. Brilliant rear signal of red, blue or green, no extra charge . . . Ideal for emergency lighting on road at night.

NATIONAL CARBIDE SALES CORP.
LINCOLN BUILDING
Opposite Grand Central, NEW YORK

ALL ALLOY STEEL HEAT TREATED DROP FORGED



THE NEW "TRIMO-ALLOY" IS INDUSTRY'S MIGHTIEST PIPE WRENCH

The red tag wired to handle is your guarantee of greater strength, safety and service.

MADE BY TRIMONT MFG. CO., ROXBURY, (BOSTON), MASS.

TRIMO

Makers of Trimo pipe cutters, vises, monkey wrenches, screw drivers and TRICROME cutter wheels

BUCYRUS-MONIGHAN

ignores rainy weather, soft ground and treacherous footing. It has a double set of supporting surfaces . . . more than double the bearing utilized by other types of draglines. When digging it is supported only on its large-area base. When walking, it is supported partly on the walking treads and partly on the base. Treads and base get fresh bearing surfaces for every move! Manufactured by Bucyrus-Monighan Company, Chicago, Illinois.

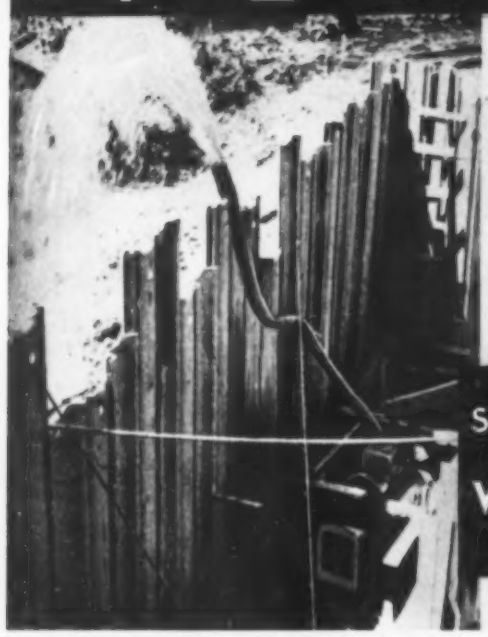
Bucyrus-Monighan Special 6160 Electric Dragline, working in the rain on the Bonneville Dam for Columbia Construction Company

BUCYRUS MONIGHAN

Sold by BUCYRUS-ERIE CO.
SOUTH MILWAUKEE, WISCONSIN, U.S.A.

Now has 5 G&R PUMPS

TRIED 1 - BOUGHT 2 MORE - AND AGAIN 2 MORE



Back in April of 1934 Mr. A. P. Munsen, of Marion, Iowa, bought his first 4" G & R Pump from the Herman M. Brown Co., Des Moines, Iowa. He liked it. When he needed more pumps for a big bridge job near Hamilton, Ill., he bought another 4" and a 6" G & R Pump from the O. T. Christerson Co., of Chicago. Later on he bought a 3" and another 6" G & R Pump from Brown in Des Moines.

Like every other contractor who tries one of these dependable, gadgetless, self-priming G & R Pumps, Mr. Munsen was at first surprised and then decidedly enthusiastic over the way this simple pump handles water, clean or dirty, on steady pumping or intermitent service. No time out for cleaning clogged orifices. No power wasted in recirculating water through a self-priming system. Fast priming, full volume pumping as long as there is water to be pumped.

Distributors in 100 principal cities are ready to make prompt delivery of the G & R Pumps you need.

We get

REPEAT ORDERS

because we give the

MOST DEPENDABLE PUMP

for the Least Money

THE GORMAN-RUPP CO.
Mansfield, Ohio

BAKER
BULLDOZERS

They Have Everything!

Ask for latest Bulletins on Bulldozers

also

GRADEBUILDERS
SCRAPERS
ROAD ROOTERS
ROAD DISCS

These simply-constructed, direct-lift Bulldozers have all the features a contractor wants. Better control — less repairs — strength for the hard jobs and better all around performance account for more Bakers on more jobs.

THE BAKER MFG. CO.
568 Stanford Ave.
Springfield, Illinois

Large Capacity and Portability

are combined
in H&B Tower Type

PORTABLE ASPHALT PLANTS

—

Hot or Cold Mix

—

Bulletin T-247

HETHERINGTON & BERNER, Inc.
INDIANAPOLIS, INDIANA
Builders of Asphalt Paving Machinery for over thirty years

FOR TUNNEL DRIVING SAVINGS "GO WHERE THE MONEY IS"- - -

●

The greatest item of expense in tunnel driving is labor. Logically, if you want to save on the estimated cost of tunnel driving it is wise to look for those savings in the largest item of expense.

And it is in labor — in man hours.

Du Pont "Ventube" owes much of its success to the fact that it saves time.

"Ventube" is quickly put into place. It is rapidly withdrawn from the working face when blasting, and it saves more time by the rapidity with which it is thrown up to the working face after blasting to exhaust gases and permit a quicker return to work by the shift.

Significant, too, is the fact that where world's records have been set in tunneling operations, du Pont "Ventube" has been used.

●

Typical "Ventube" installation showing two lines of "Ventube" carrying fresh air to the working face, and one line used for rapid exhausting of gases from working face.

CONSTRUCTION EQUIPMENT

To Fulfill Contracts Speedily and Profitably

New developments and improvements in Blaw-Knox Construction Equipment are right in step with today's program.

With a background of years of practical experience, Blaw-Knox equipment is trustworthy. It is economical and low in maintenance. Designed to stand up under severe operating conditions, it is fitted to the job by skilled engineers. It helps immeasurably to fulfill contracts speedily and profitably.

BLAW-KNOX COMPANY, 2086 Farmers Bank Building, Pittsburgh, Pa.
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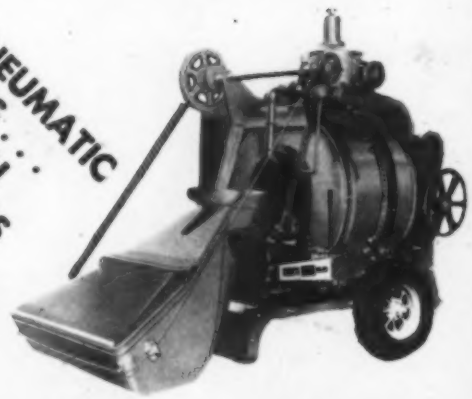
FAST · MODERN !

PNEUMATIC TIRES . . . TIMKEN BEARINGS



C. M. C. TWO WHEELERS

Buy the latest Mixing Equipment. The C. M. C. line leads in money and time-saving improvements. New 7S and 10S Two Wheelers have made friends with contractors all over America.

WRITE FOR NEW BULLETINS

Show complete line of modernized C. M. C. Equipment including Master and Silverstreak Non-Tilts from 3½S to 28S, Wonder Tilters from half-bag to two-bag capacity, C. M. C. Hoists, Plaster and Mortar Mixers, Pumps, Saw Rigs, BETTER-BUILT Wheelbarrows, DUMPOVER Concrete and Material Carts.

CONSTRUCTION MACHINERY CO., WATERLOO, IOWA

"CLEANING HOUSE" with a MORETRENCH WELLPOINT

means a perfect installation in a hole that is washed clean of fines, mud, silt, etc., using one hundred per cent of the jetting water. NO BACK WASTE. The Moretrench valve set-up prevents that. Does it work? Listen!

A Massachusetts sewer contractor recently spent six weeks figuring out why rosy promises didn't materialize—then he sent in a complaint. Two "experts" came up, spent a few days around town, and told him that no wellpoint could dry that ditch up any better than it was—and they didn't bar Moretrench either. A quiet call went in and two days later a long distance Moretrench truck delivered the goods. *Daily progress changed at once from a wet maximum of forty feet to a dry hundred and ninety feet—first crack.* A second outfit was ordered and another job started. Does it pay? We leave that to you!

MORETRENCH CORPORATION

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Works:
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Crawler Tractors
Built To Endure
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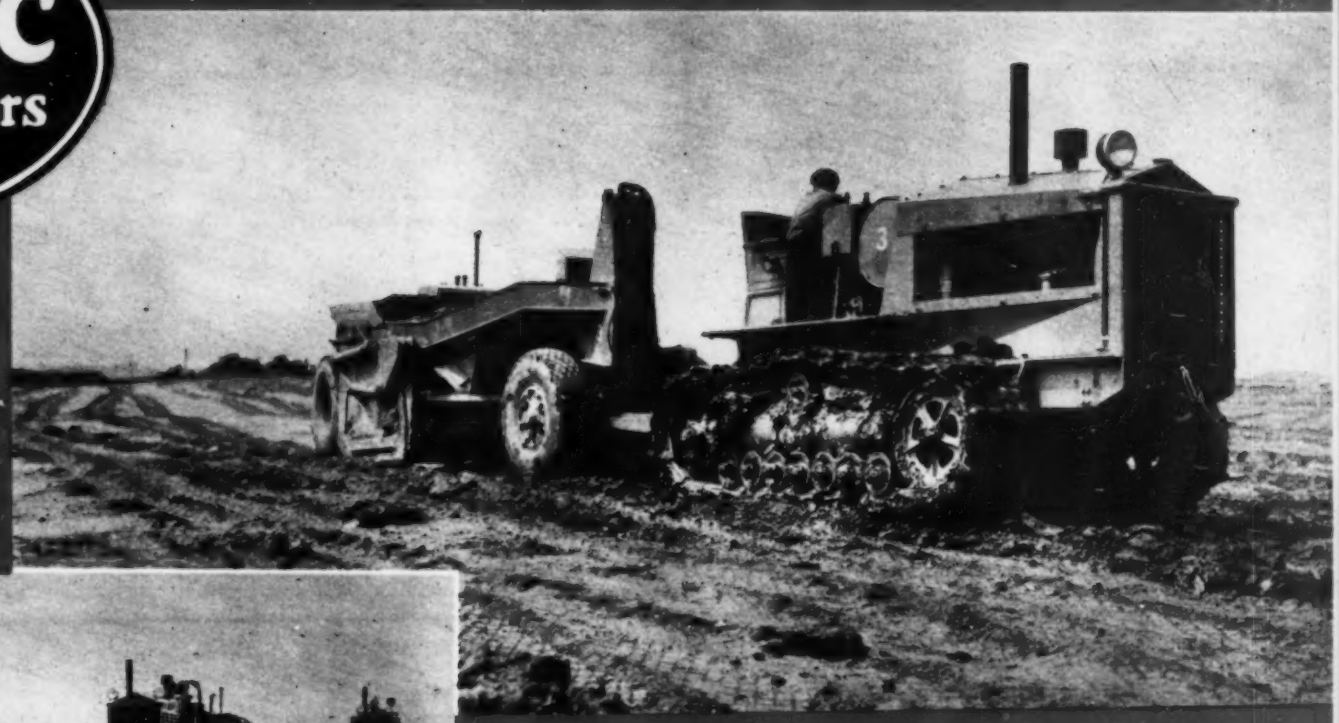


(Below)
Knoxville, Tenn.
Airport

Loving Field,
Pulaski, Va.

Latrobe, Pa. Airport
W. P. A. Project

Proved
PERFORMANCE

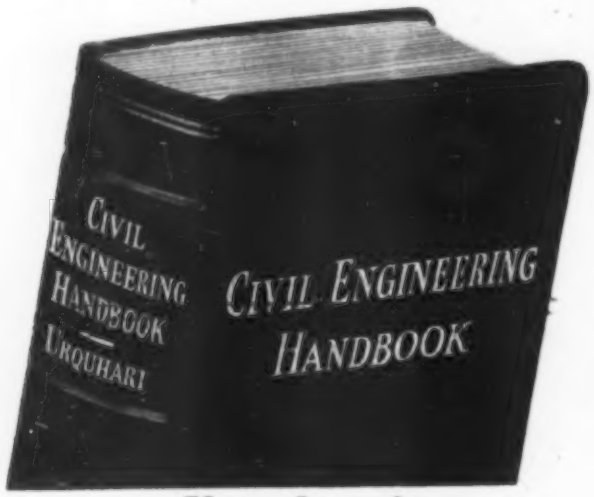
All across the country there is a wave of airport development—construction of new air fields and improvements on old ones. • Cletracs proved performance has caused them to be selected repeatedly for airport work all over the country. • Wherever Cletracs have been placed on this work they have established records of profitable and money-saving performance.

THE CLEVELAND TRACTOR CO.
CLEVELAND, OHIO

10 basic treatises

covering the entire field of civil engineering—emphasizing material needed by engineers—presenting adequate and usable treatments of essential topics.

In one new handbook at the low price of $5.00



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CIVIL ENGINEERING HANDBOOK

By Leonard C. Urquhart, *Editor-in-Chief*
and a Staff of Specialists

885 pages, 6 x 9, profusely illustrated, flexible, $5.00

UP-TO-DATE, authoritative, new in approach, this book makes available to civil engineers a manual of unusual value. In one volume it presents the fundamentals of the various subdivisions of civil engineering, for the use of practicing engineers, especially when confronted with problems outside their specialized fields. In each division a noteworthy specialist has contributed a compact treatise, developing fundamental theories as well as stating more involved ones, making the book not only a comprehensive reference work, but also adaptable for systematic study of any of the fields represented in it.

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REG. TRADE MARK

ELECTRIC HAMMERS

A Battery of B-5's Drilling ⅝" Seating Holes in a Baseball Park

SYNTRON ELECTRIC HAMMERS have a capacity of drilling holes in concrete up to 2 inches in diameter, but speed in drilling smaller holes makes them the favorite tool on jobs where there are thousands of holes to be drilled for fastening seats, stringers, railings, etc.

They can also be used for many other purposes, using different tools — with chisels and points for cutting concrete — with bushing tools for surfacing — with blunt tools for vibrating concrete — and for scaling paint and rust from metal.

Write for bulletin giving complete details.

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Pittsburgh

IF you have leakage through structurally sound masonry

Dams · Retaining Walls · Filter Beds · Sewage Tanks · Pump Pits · Tunnels · Manholes · Walls · Floors · etc.

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WATERPROOFING

SIKA mixed with portland cement is easily applied by hand and will successfully seal off infiltration from inside even under Pressure.

Write us about your waterproofing problems.

SIKA, Inc.

1943 Grand Central Terminal, New York, N. Y.

23rd Engineers—ATTEN-SHUN!

THE 23rd Engineers Reunion Committee is holding the first National Regimental Reunion since demobilization in 1919 at Cleveland, Ohio, September 20th to 25th inclusive.

The Committee has established headquarters at the Union Trust Building, in the heart of downtown Cleveland with adequate facilities for renewing old friendships. A very appropriate program has been arranged to make your stay in Cleveland enjoyable.

Every member who served with the Regiment is cordially invited to attend this Reunion, and should, whether he attends or not, register with the Secretary.

Twenty-Third Engineers Reunion Committee
Robert T. Black, Chairman
F. Brad Manker, General Chairman
George W. Powers, Secretary

Members of the 23rd Engineers are scattered all over the world—but even as *Business Paper Broadcasting* played so important a part in bringing the old outfit together in the first place (who of you will ever forget the celebrated slogan on page after page "Your chance to help show the world what American Road Builders Can Do?") so *your Business Paper* becomes a logical medium through which to sound assembly for the 1936 Reunion.

***Construction Methods* takes pleasure in broadcasting the invitation.**

Wherever you may be, if you are one of the 23rd Engineers, please write Secretary Powers today that you are coming to the 1936 Reunion.

Be sure to REGISTER.

Address: George W. Powers, Secy., Box 6234, Cleveland, Ohio

MICHIGAN TRUCK CRANES

MEET the MICHIGAN TRUCK SHOVEL—

through the pages of Michigan's new booklet picturing a score of uses for this fast convertible shovel and crane . . . It contains many on-the-job photographs of the Michigan being used as a shovel, crane, trench hoe, dragline, clam, etc., together with description and specifications. Here is the answer to the large operators' equipment shortage problem. For the smaller user, the Michigan represents a wide range of uses built into one piece of equipment. For every buyer, the Michigan offers the most in mobility, dependability and economy . . . Write for Bulletin CM today.

MICHIGAN POWER SHOVEL CO., BENTON HARBOR, MICHIGAN

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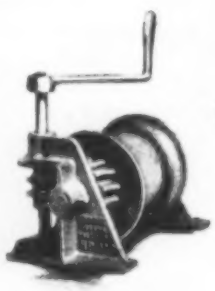

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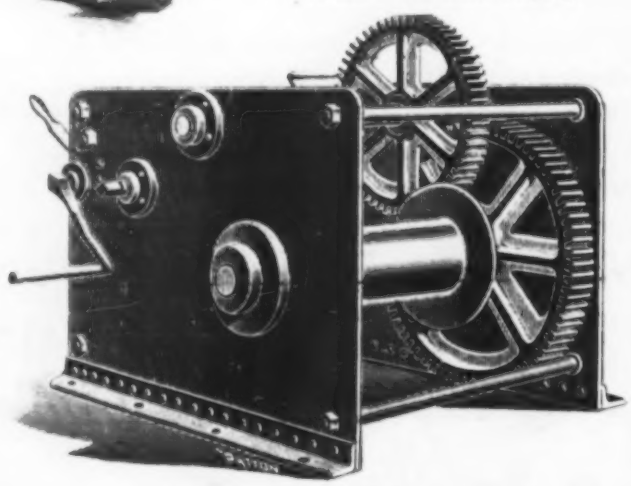
From 100 pounds to 50,000 pounds capacity on a single line.
With ease and safety.



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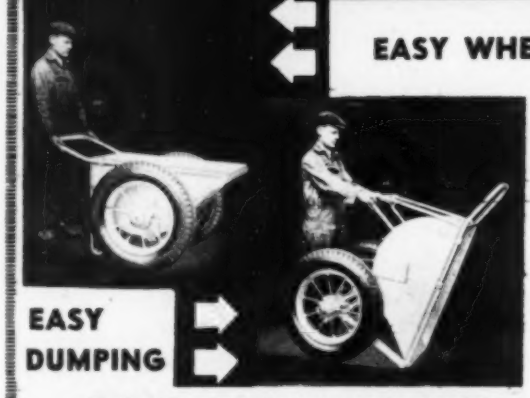
Other Dobbie Products — Steel Derricks, Timber Derrick Fittings, Hand Winches, Motor Driven Winches, Blocks, Sheaves, etc.

New CMC "DUMPOVER" PNEUMATIC TIRED CART

EASY WHEELING



Standard size balloon tires—obtainable anywhere.

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ONE MAN WHEELS AND UNLOADS TWICE AS MUCH!

Actual dynamometer tests prove that it takes only *half the force* to move the C M C DUMPOVER that it does the ordinary cart with steel wheels. IN DUMPING THIS NEW C M C CART very little effort is required. Exclusive chassis construction with perfectly balanced tray enables operator to unload cart *completely* without lifting wheels and chassis. No hoeing, shoveling or bumping necessary.

Three convenient sizes 6½ cu. ft., 9 cu. ft., and 11 cu. ft. Write for bulletin telling the complete story of these new carts.

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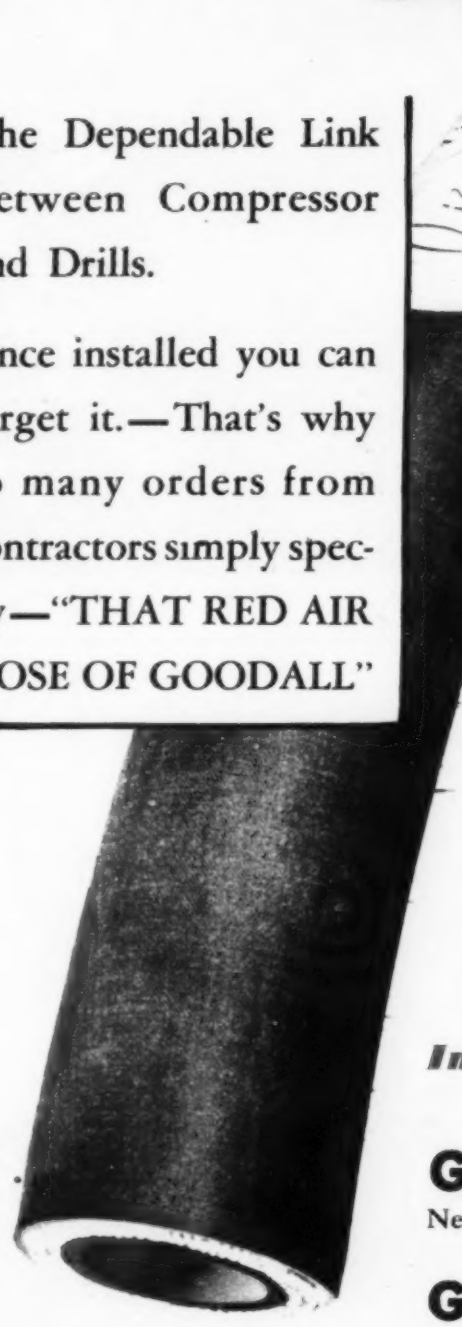
"SUBWAY" BRAND AIR HOSE



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Time-tested Special Alloy Steel gives longer wear.

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3-STAR
PINNACLE
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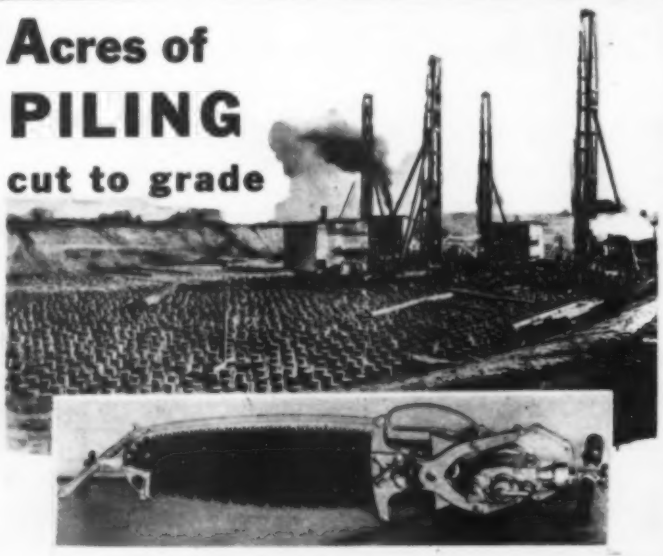

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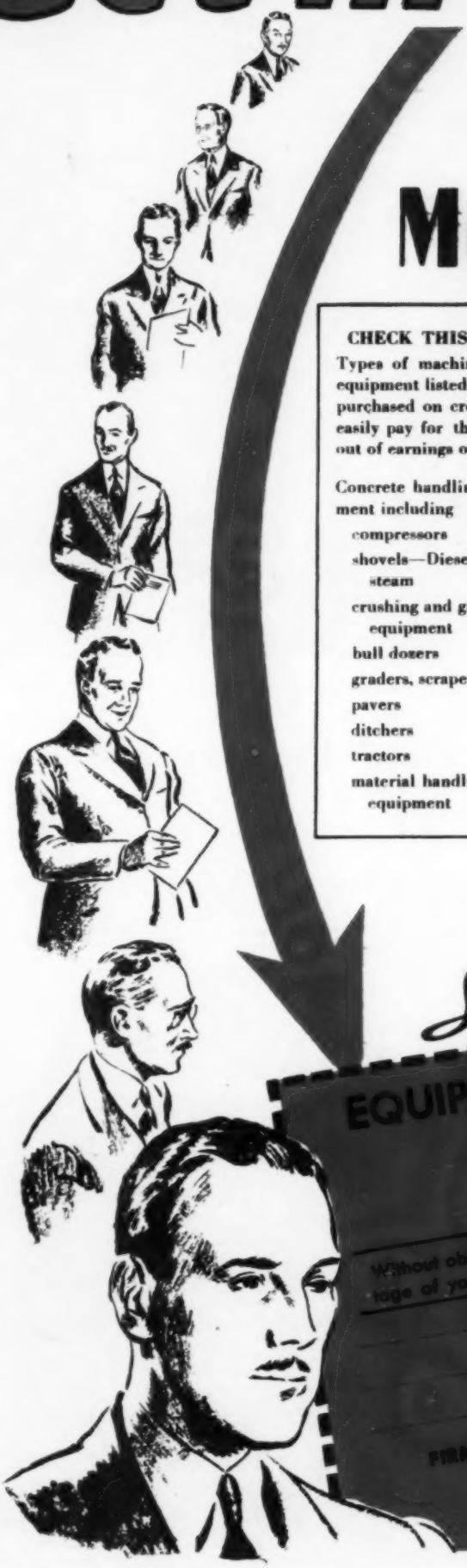

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Make concrete pipe on the job with *Quinn Pipe Forms*. Gives employment AT HOME where it is needed. Quinn Pipe Forms can be handled by less experienced labor and produce uniform concrete pipe of highest quality.

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Built to give more years of service—sizes for any diameter pipe from 12 to 84 inches—tongue and groove or bell end pipe—any length. Backed by years of service in the hands of contractors, municipal departments and pipe manufacturers.

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Meet the demand for low cost equipment that produces a uniform quality of pipe in smaller amounts. Complete in every way. Stands up on any job. Same sizes as "Heavy Duty," from 12 to 84 inches—any length.

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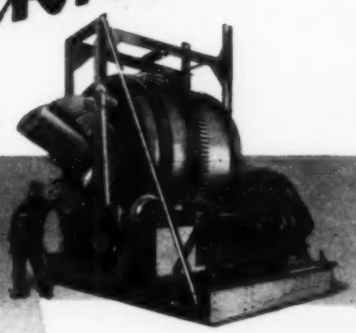

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FAST & TOUGH

That's what the big pipe line job was from Zionville, Indiana to Detroit—the largest city in the world to be served by natural gas.

Fast, tough dewatering pumps had to be used to bring this pipe line through swamps, peat bogs and across seven rivers.

That's right! Novo Self-Primers and Diaphragm Pumps were used on both ends of this job.

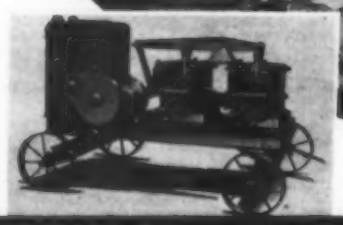
The United Engineers Construction Company of Detroit used Novo Self-Primers. Bibb Contracting Company used Novo Diaphragm Pumps across Indiana and Ohio. Both obtained the same results—fast, dependable performance, the going was tough and they came through in record time with this two hundred thirty miles of twenty-two inch pipe line.

Here are two types of pumps that you can't stump. The explanation is easy. These are high powered pumps; meaning they have the largest engines—size for size, that are put on dewatering pumps.

NOVO

Send the Coupon for full information

On Novo Dewatering Pumps, Pressure Pumps, Road Pumps and Sludge Pumps. There are also Novo Hoists, Pavement Breakers and Light Plants.



Above (in circle) are two Novo 2-in. Self-Priming Centrifugal Pumps dewatering the trench for Detroit's natural gas line going through a swamp in Wayne County, Michigan. This is the United Engineer end of the job.

At the left is a Novo Double Open Top Diaphragm Pump as used by the Bibb Construction Company on their end of the job.

NOVO ENGINE COMPANY
216 Porter Street, Lansing, Michigan

Send information on Novo Self-Primers ____
Diaphragm Pumps ____ Pressure Pumps ____
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Name ____
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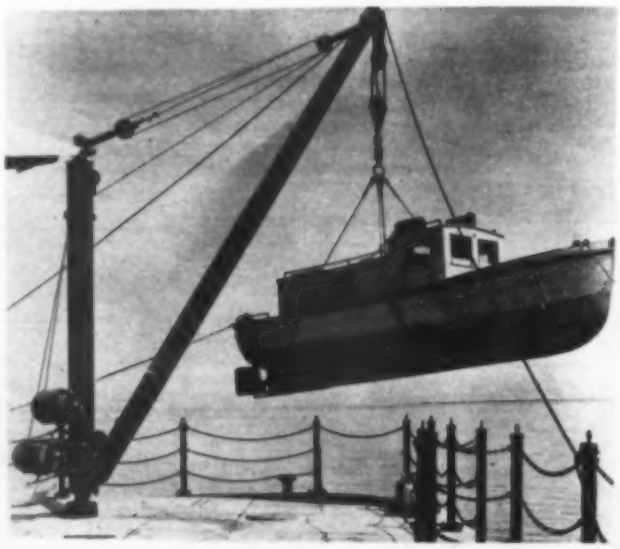

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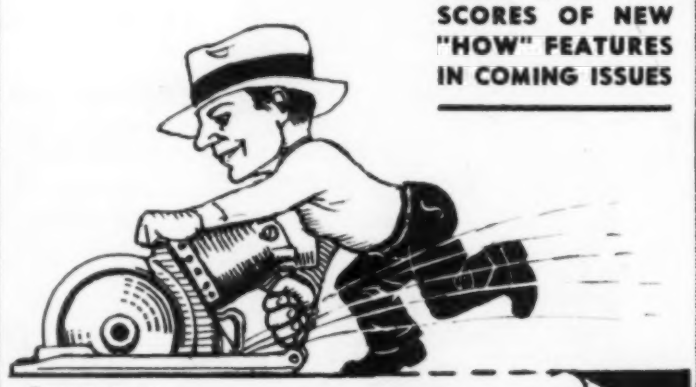

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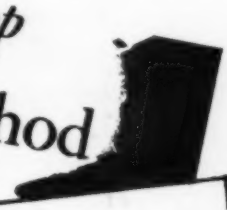

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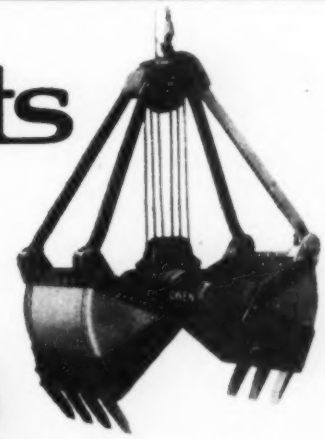

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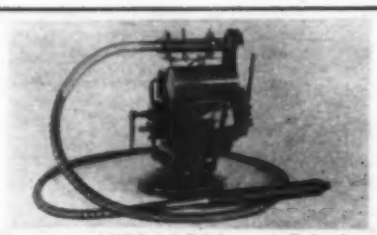
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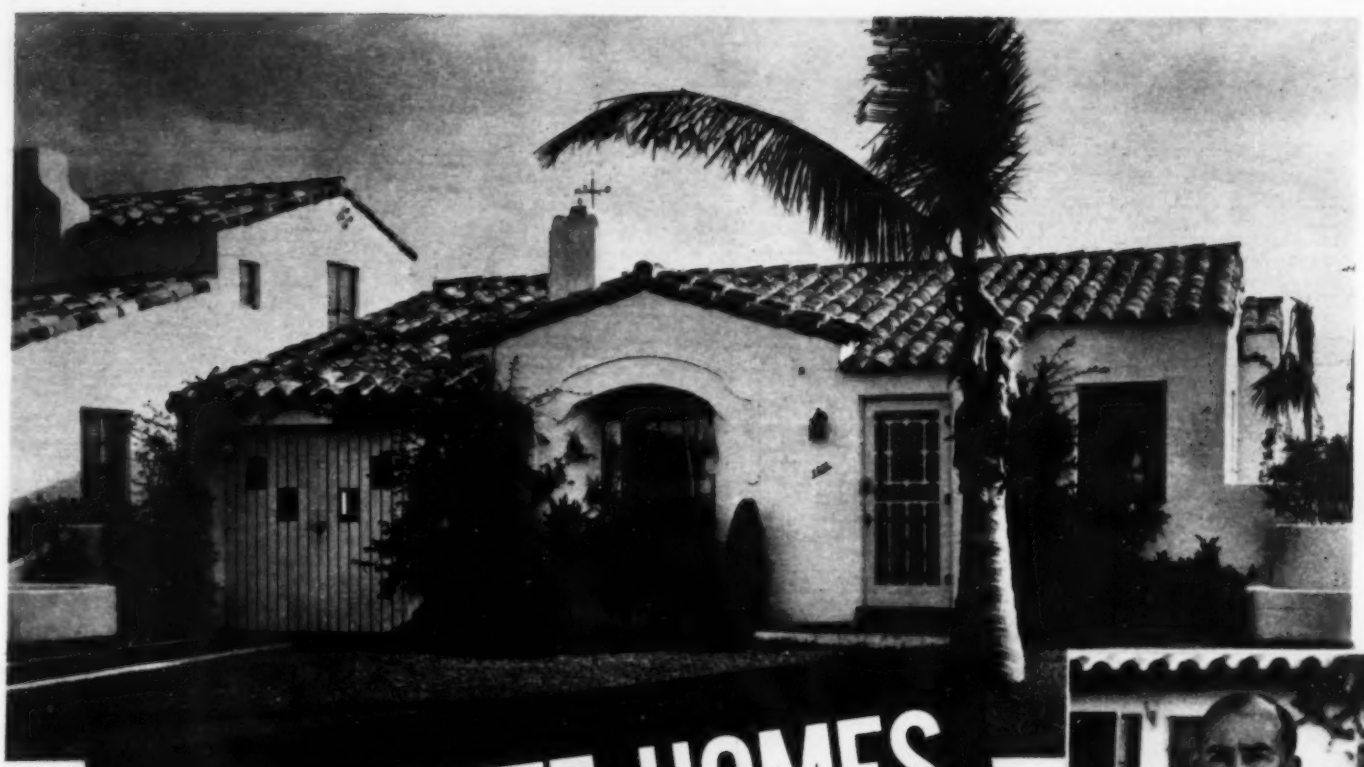

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